AMBIENT AIR SURVEY IN THE NANTICOKE AREA

MAY-JUNE 1979

ARB-TDA REPORT No. 03-80

PUBLISHED JUNE 1980

Ontario
Ministry of the Environment

The Honourable
Harry C. Parrott, D.D.S.,
Minister

Graham W. S. Scott, Q.C.,
Deputy Minister

AIR RESOURCES BRANCH

Technology Development and Appraisal Section

Monitoring and Instrumentation Development Unit

ARB-TDA Report No. 03 - 80

AMBIENT AIR SURVEY

IN THE

NANTICOKE AREA, May-June 1979

Ontario Ministry of
the Environment,
880 Bay Street,
Toronto, Ontario.

June, 1980.

TABLE OF CONTENTS

01. Summary

An ambient air monitoring survey was undertaken by the Monitoring and Instrumentation Development Unit of the Air Resources Branch in the Nanticoke area during May and June, 1979. This work was a component of the Nanticoke Environmental Management Programme.

The suspected major pollutant source in this area was the Nanticoke Industrial complex which included the Ontario Hydro Nanticoke Generating Station (Nant. GS), the Stelco Steelworks and the Texaco Company of Canada Ltd. refinery. This complex was located on the north shore of Lake Erie, approximately 55 km southwest of Hamilton, Ontario. During this survey, the Nant. GS and the Texaco refinery were in operation; however, Stelco was still in the "burn-in" stages.

The main aim of the survey was to determine ground level concentrations of various pollutants within the Thermal Internal Boundary Layer (TIBL), developed by lake breeze/on-shore flows on sunny days. Since the establishment of the TIBL required a significant temperature difference between the lake and the land, this atmospheric condition was not usually present until late morning. Thus, all ambient air monitoring was carried out during this time and into the afternoon. Approximately 163 hours of data were acquired from 34 different monitoring sites during this survey.

Sulphur dioxide (SO_2) was one of the more important pollutants monitored. The overall average ground level concentration (glc) of SO_2, as recorded throughout all the monitoring periods, was 0.05 ppm with an associated standard deviation 0.06 ppm.

Only during one monitoring period, did the 30-minute average glc of SO_2 exceed the Standard (0.30 ppm). The maximum 30 minute average glc was 0.5 ppm and this value was recorded on June 14th at a site 16 km downwind of the Nant. GS. This site was probably in a fumigation zone of the Nant. GS plume.

Other important pollutants monitored were the oxides of nitrogen (NOx). The overall average glc of NOx, as recorded throughout all the monitoring periods, was 0.031 ppm with an associated standard deviation of 0.034 ppm. The NOx Standard (expressed as NO_2) of 0.27 ppm was, at no time, exceeded by the 30-minute average glc. A strong correlation between the ambient air concentrations of SO_2 and NOx was found to exist throughout the survey, which suggested a common source, most likely the Nant. GS.

Although the analyzer for H_2S was also sensitive to other reduced sulphur compounds, H_2S was assumed the major gaseous component due to the source emissions. During this survey, low concentrations of H_2S were detected. For all the monitoring periods the overall average glc was 0.002 ppm with an associated standard deviation 0.001 ppm. This suggested that a uniform background concentration of H_2S was present in the Nanticoke area. At no time did the 30-minute average glc of H_2S exceed the Standard of 0.02 ppm and very little correlation was found between H_2S and SO_2 concentrations. Seepage from local gas wells was probably the major source of this gaseous pollutant.

Relatively high concentrations of ozone (0_3) were detected throughout this survey. The overall average glc was 0.058 ppm with an associated standard deviation of 0.053 ppm. Throughout the entire survey the 0_3 Standard of 0.1 ppm was reached or exceeded on 3 separate occasions by the 30-minute average glc's. The maximum 30-minute average glc recorded was 0.380 ppm. Correlation statistics between SO_2, H_2S, and THC versus 0_3 depicted no relationship nor discrete source(s) identification. As a result, O_3 was thought to have an extraneous origin.

The concentrations of the total hydrocarbons (THC) was of interest because of possible interaction of photochemically active hydrocarbon constituents with NO_x to form secondary pollutants. Generally, very low concentrations of THC were detected. For the entire survey, the overall average

glc of THC was 1.55 ppm with an associated standard deviation 0.84 ppm. The highest maximum 30-minute average glc was recorded while the Texaco plume was being monitored and its value was 5.5 ppm. The monitoring van was located 5.5 km downwind of the Texaco refinery.

Twenty three direct injection samples, as well as 19 airborne cartridge samples and 82 ground-based, time averaged, cartridge samples were analyzed for individual hydrocarbon concentrations by the gas chromatograph associated with the Mobile Air Monitoring (MAM) unit. Results from this study showed that background concentration levels of ethene, acetylene, propane and propene, cyclopropane, 2,2-dimethylpropane, 3-methylbutene, n-hexane, benzene, n-heptane, and toluene were detected. Geometric standard deviations were used to examine the possibility of a single source emission of certain hydrocarbons. The Nanticoke industrial complex was considered a possible source of n-pentane since a high geometric standard deviation of 9 was found. Sampling of n-butane and n-butene, and isobutane downwind of the Texaco refinery also produced fairly high geometric standard deviations (3 and 4 respectively) which suggested that Texaco was a possible source for these hydrocarbons. However, as is further discussed in the Air Resources Branch/TDA report "Evaluation of Hydrocarbon Study at Nantiocke May/June 1979", there are other possible sources present for these hydrocarbons. These include helicopter exhaust, abandoned gas and oil wells in the area, pipelines and underwater gas and oil wells at the lakeshore.

For further information on the emissions of hydrocarbons from the storage tank area of the Texaco refinery, refer to Air Resources Branch/TDA report #25-80.

0.2 Introduction

As requested by the Nanticoke Environmental Management Programme (NEMP) of the Air Resources Branch, the Monitoring and Instrumentation Development Unit of the Air Resources Branch conducted an ambient air survey in the Nanticoke area, during the period of May 28th through June 14th 1979.

Sulphur dioxide as well as oxides of nitrogen were the gaseous pollutants of primary interest. The suspected source, as determined by the survey carried out in 1978, (refer to ARB-TDA Report No. 54-78), was the Nanticoke Generating Station (Nant. GS) owned by Ontario Hydro and located on the north shore of Lake Erie, approximately 55km southwest of Hamilton, Ontario. Also of interest were the concentrations of hydrocarbons potentially emitted by either the Texaco refinery, located just northeast of the Nant. GS, or by oil and gas fields in the area. During the 1978 survey, the Texaco and Stelco industrial complexes were either under construction or at the initial "burn-in" stages and both produced very little gaseous emissions. During the 1979 survey, Texaco was in operation and Stelco was still under construction. The MAM unit also recorded glc's of other gaseous pollutants to serve as a data bank on a regional basis and a variety of ground-based meteorological parameters.

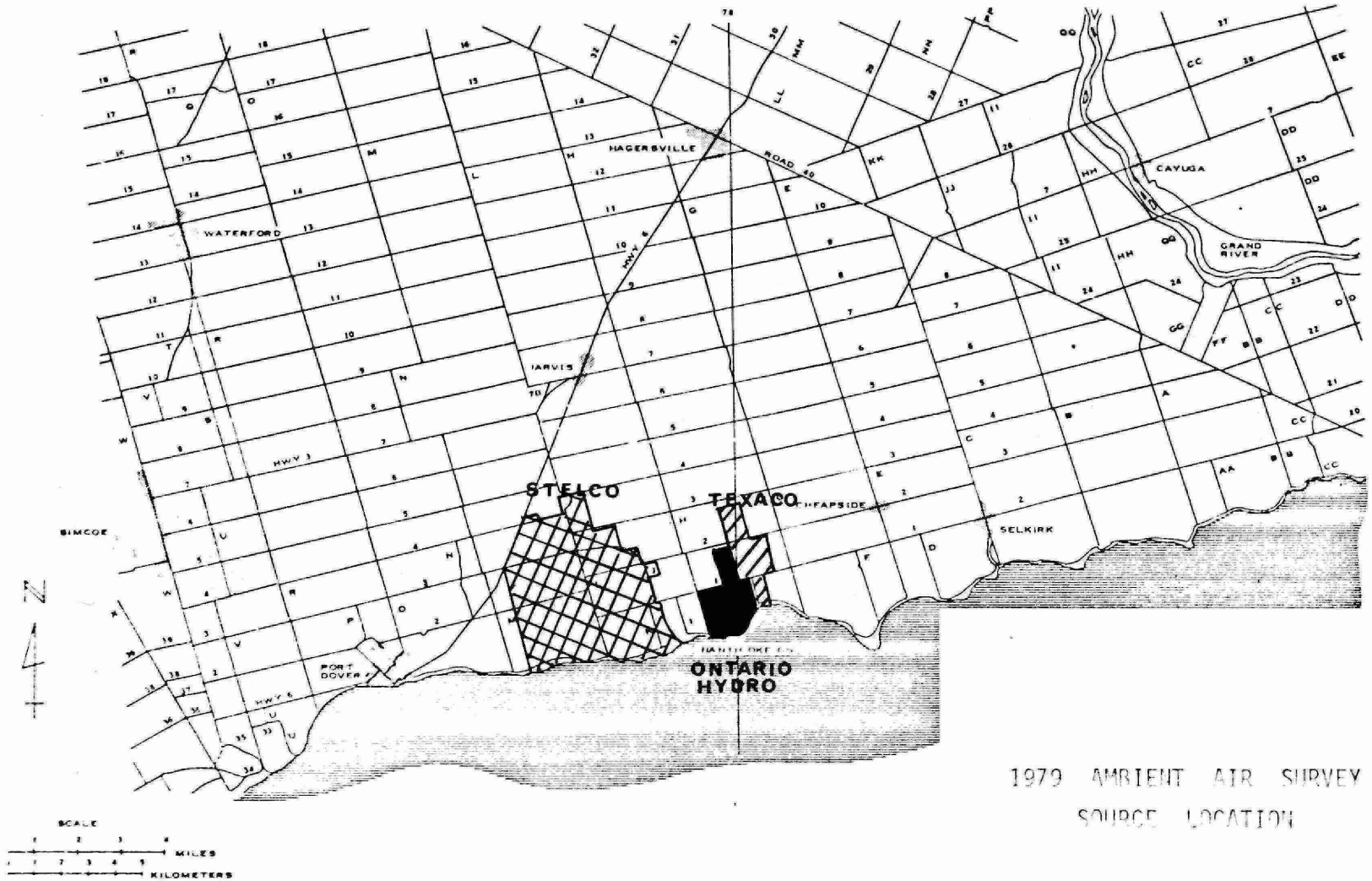
Plume tracking, from the Texaco refinery and the Nanticoke Generating Station under various atmospheric conditions, was also a main concern during this survey and was the primary responsibility of the NEMP group.

03. Source Descriptions

The Ontario Hydro Nanticoke Generating Station is located approximately 55 km southwest of Hamilton on the north shore of Long Point Bay (Lake Erie). This station is coal fired and, at this time, was operating at capacities varying between shut down and 67% of its present operating capacity of 2000 M.W.

The Texaco refinery located just northeast of the Nanticoke Generating Station burns fossil fuels and is a diffuse source of various hydrocarbons.

These plants as well as the Stelco industrial complex are shown in Map #1, page 8.



NANTICOKE GS – AIR POLLUTION SURVEY AREA

MAP #1

04. Survey Technique

Analytical instrumentation housed in a 1975 General Motors Corporation Transmode (MAM Unit) was utilized to monitor the air quality in the vicinity of the Nant. GS and the Texaco Refinery. This unit was equipped with an automated data acquisition system (Hewlett & Packard 9830A mini-computer) and on-board electric generators for fully automated, independant and continuous monitoring capabilities. The HP 9830A mini-computer performed initial data analyses in the field (re: accuracy & validity) whereas the final data reduction and analyses were carried out by a larger computer system located within the Air Resources Branch at 880 Bay Street, Toronto.

The MAM unit had permanently installed analyzers for monitoring sulphur dioxide, hydrogen sulphide, oxides of nitrogen, total hydrocarbons, and methane. The analyzer for carbon monoxide was not functioning properly during this survey. Meteorological instrumentation for monitoring wind speed, wind direction, relative humidity, temperature, barometric pressure and solar radiation was also included in this instrumentation package. A gas chromatograph (GC) unit was set up for monitoring hydrocarbons and was extensively used throughout this survey. See Table #1, page 11, for listing of the above.

Through cooperation with the NEMP group, approximate locations of maximum glc (impingement zones) were found and ambient air monitoring was initiated. Air quality was continuously monitored for at least 45 minutes at each location and, whenever possible, farther downwind monitoring was undertaken.

Due to the relative difference in effective stack heights between the Nant. GS and Texaco, their respective impingement zones were often distinguishable. Texaco, being a low level emission source, has its plume either emitted within the TIBL or the plume encounters the TIBL within a relatively short

distance. As a result, plume impingement from Texaco was often found much closer to its origin. The plume from the Nant. GS, was emitted at a much higher level and carried by the stable air aloft until it reached the TIBL much farther downwind where it fumigated. As a result of this plume differentiation feature of the TIBL, it is felt that deposition of emissions from the Texaco refinery would contribute only a small portion to the glc's in the fumigation zone of the Nant. GS plume. This was also evident since no apparent increase was observed in the glc's of O_3 monitored farther downwind; whereas, if emissions from Texaco (hydrocarbons) had contributed to the glc's in the fumigation zone, more O_3 would have been produced. The distance between the source and the point of impingement depended greatly on the height of the TIBL and hence with time of day because of the input of solar radiation.

Ambient air hydrocarbon samples were collected in cartridges, some of which were placed in the field at several distances and directions from the sources. Airborne cartridge samples were also collected by helicopter while traversing the plume. These cartridges were then analyzed by the G.C. for concentrations of the following hydrocarbons: ethene, acetylene, propane and propene, cyclopropane, isobutane, n-butane and n-butene, 1,3-butadiene, 2,2-dimethylpropane, n-pentane, 3-methylbutene, n-hexane, benzene, n-heptane, and toluene.

TABLE #1

INSTRUMENTATION - GMC

Instrument	Manufacturer	Analytical Technique	Maximum Sensitivity (Full Scale)
H_2S Source	Hartmann & Braun (H&B Prüfgasgenerator)	N/A	N/A
H_2S Analyzer	H&B Picos	electrochemical	0.05 ppm
SO_2 Source	H&B Prüfgasgenerator	N/A	N/A
SO_2 Analyzer	H&B Picoflux 2	conductometric	0.3 ppm
O_3 Analyzer/ Source	Bendix 8002	chemiluminescent	0.05 ppm
NO_x, NO_2, NO Analyzer	Bendix 8101-B	chemiluminescent	0.5 ppm
CO Analyzer	H&B Uras 2T	Infrared Absorption	50 ppm
THC, CH_4, THC-CH_4 Analyzer	Ingenieur - Produktions-Gruppe München (IPM) RS-5	Dual flame ionization detector	50 ppm THC (as CH_4)
Hg Analyzer	Scintrex HGP-2	Ultra-violet Absorption	200 ng/m^3
CO, THC, THC-CH_4, CH_4 source	Matheson	compressed gas	N/A
Hydrocarbons chlorinated hydrocarbons, PAN, etc. analyzer	Hewlett & Packard Gas Chromatograph 5830A System	Retention time as measured by electron capture, thermal conductivity, or flame ionization detectors	As set by calibration procedure

Instrument	Manufacturer	Scale
Wind Speed	Lambrecht gmBH	km/hr
Wind Direction	Lambrecht gmBH	degrees
Temperature	Weather Measure (WM) T621	^oC
Relative Humidity	WM-HM-111P	percentage
Barometric Pressure	WM-BM70-B242	millibars
Solar Radiation	WM Star Pyranometer	watts/cm^2

05. Monitoring Technique

i) Sample Collection

The ambient air sample was taken at a constant flow rate (approximately 0.2 cubic meters/min) by a probe located on top of the MAM unit, the inlet of which was approximately 5 meters above ground level. The air sample entered a manifold where each analyzer was parallel tapped with a minimal length of teflon sampling line. This arrangement ensured little or no sample degradation, minimal delay time and sample contamination due to ground level sources (eg. entrained soil, vehicular traffic, etc.).

ii) Instrumentation - analyzers

The instrumentation associated with the GMC Transmode unit is presented in Table #1, page 11.

iii) Instrumentation - G.C. and Hydrocarbon Sample Collection Methods

The analysis of hydrocarbons in ambient air was performed by a Hewlett-Packard Gas Chromatograph (HP 5830A) and a microprocessing unit (HP 18850A G.C. terminal). Operating parameters were monitored automatically by the microprocessing unit once the programme was entered.

With respect to the G.C., the column consisted of 4.25 m of SS tubing, 2mm I.D., packed with Porapak N, mesh size 80-100. Temperature programming was used with Nitrogen as the carrier gas flowing at 40 ml/min with the temperature at 80^{o}C for 7 minutes, then 16^{o}C/min up to 190^{o}C and held for 10 minutes. To monitor the hydrocarbons, the G.C. used a flame ionization detector (FID) at a temperature of 250^{o}C.

Three methods were employed to collect ambient air samples for G.C. hydrocarbon analysis. One method, involved drawing air from the MAM's primary manifold at a flow rate of 100 ml/min for 30 minutes sequentially onto one of two glass adsorption cartridges. These cartridges were 4mm I.D., packed with Molecular Sieve 5A, mesh size 40-60, with adsorption at ambient air temperature and a flow rate of approximately 50ml/min. This air sample was thermally desorbed at 300°C with N_2 as the carrier gas and automatically injected into the G.C. for analysis.

The second method used a helicopter to collect airborne ambient air samples while traversing the plume. The air was drawn at approximately 50ml/min through a glass cartridge containing Molecular Sieve 5A. Sample times varied for each sample, but were normalized to a volume of 1500 ml for G.C. analysis. Plume traversal was carried out in such a fashion as to avoid picking up helicopter exhaust emissions. Some direct sampling of helicopter exhaust fumes was also done in order to check characteristic hydrocarbons emitted in this way, and thus, possible "fingerprints" for exhaust contaminations.

Finally, the Nutech sampling method was employed for the other ground-based field samples. In this process air, was drawn through a glass cartridge filled with Molecular Sieve 5A, at a flow rate of 50 ml/min for a sampling period of 60 minutes. Some parallel sampling was done at 100 ml/min for 60 minutes in order to check for breakthrough. Within 24 hours, after the sample was collected, the cartridges were thermally desorbed and analyzed by the G.C. in the MAM unit.

For the G.C., the external standard calibration procedure was used. A 1 ml sample of air which contained a known concentration was

extracted from the multilayer aluminized polyester (Mylar) bags. This sample was then injected into the carrier gas (clean air) with a motorized syringe pump and collected on cartridges containing Molecular Sieve 5A. For the samples taken by the MAM unit, this cartridge was located inside the preconcentrator -"monster", and for the Nutech samples, the cartridge was external to this unit. The sample was heated to 300°C and desorbed with the G.C. carrier gas (N_2) on the column to be monitored by the FID.

iv) Meteorological Analysis

Meteorological conditions were monitored on a continuous basis by the instrumentation associated with the GMC MAM unit (REF Table #1, page 11).

Additional information regarding air mass movements and daily weather statistics was provided by Atmospheric Environment Service.

v) Calibration

Analyzers and sources were calibrated before the survey. During the survey, the analyzers' calibration was checked at least once every day using the sources and built-in electronic circuitry. All monitors were found to be extremely stable and the calibration remained within the prescribed limits throughout the duration of the survey. Immediately following the completion of this survey, all instruments were rechecked in the laboratory and all calibration statistics were found to be satisfactory.

06. Monitoring Site Locations

The ambient air monitoring sites of the MAM unit are shown on Map #2, Page 16, and their associated descriptions are presented in Table #2a, pages 17-19. Over 163 hours of data were accumulated at these 34 reported monitoring sites.

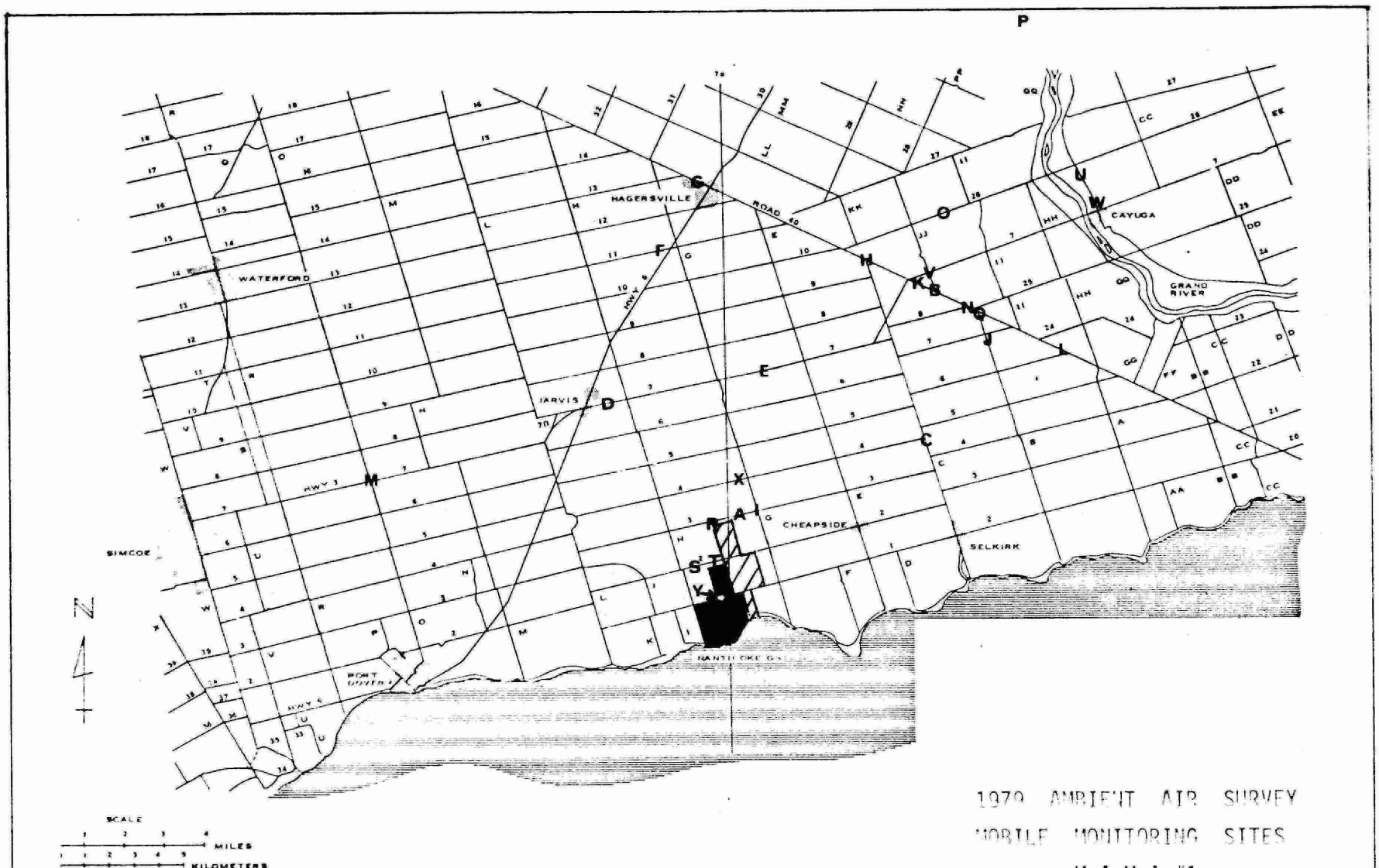
The sites are presented in chronological order, however, omissions were made, as noted by the numbering scheme. The omissions were based on insufficient data. Forty-five minutes were deemed the minimal observation period in order to establish a "true" 30 minute average ground level concentration of the gaseous pollutant of interest.

All monitoring sites labelled /Hydro were referenced to the main stacks of the Nanticoke Generating Station, UTM co-ordinates 05780-47386. Those labelled /Texaco were referenced to the Texaco refinery stacks, UTM co-ordinates 05782-47422.

The monitoring sites of the ambient air samples collected by direct injection aboard the MAM unit for hydrocarbons, are also shown on Map #2, page 16, and their associated descriptions are presented in Table #2b, page 20.

The paths taken by the helicopter while collecting airborne cartridge samples of hydrocarbons are shown on Map #3, page 21, and their associated descriptions are presented in Table #3, page 22.

Map #4, page 23, presents the locations of the ground-based samples for hydrocarbons. Their associated descriptions may be found in Table #4, pages 24, 25 and 26.



NANTICOKE GS – AIR POLLUTION SURVEY AREA

M.A.P. #7

TABLE #2a

Mobile Air Monitoring Sites

Nanticoke III Survey - 1979

Site	MAP I.D.	Location and UTM Co-ordinates	Distance (km)	Bearing (DGS)	Date/1979
1.	A	Conc #3, 0.3 km, W. Sandusk Rd. (05786 - 47438) / Texaco	2	000	May 28
2.	B	Dry Lake Rd. & Hwy. #40 (05868 - 47523) / Hydro	16	035	May 29
3.	C	Selkirk Rd. & Conc. #4 (05861 - 47467) / Hydro	11	050	May 29
4.	D	Explorer Hotel (05730 - 47483) / Hydro	10.5	335	May 30
5.	E	Hwy. #3, 1.2 km E. Sandusk Rd. (05790 - 47495) /Hydro	11	010	May 30
6.	F	.05 km W of RRWY, W of HGWY #6 on Conc. 11 (05755 - 47545) /Hydro	16	350	May 30
7.	G	Hwy. #40, .5 km NW Hwy. #6 (05770 - 47570) /Hydro	18	355	May 30
8.	D	Explorer Hotel (05730 - 47483) / Hydro	10.5	335	May 30
9.	D	Explorer Hotel (05730 - 47483) /Hydro	10.5	335	May 31
10.	D	Explorer Hotel (05730 - 47483) /Hydro	10.5	335	May 31
11.	H	Hwy. #40 & Selkirk Rd. (05841-47537) /Hydro	15	020	June 2
12.	I	Sandusk Rd., .1 km S. Conc. #3 (05793 - 47438) /Texaco	5.5	015	June 3
13.	J	Fisherville Rd., .2Km S Conc. #7 (05887 - 47505) /Hydro	15.5	045	June 4
14.	K	Hwy. #40, .5km SE Nelles Corners (05858 - 47528) /Hydro	15.5	030	June 4
16.	L	Hwy. #40 near Conc. #6 (05918 - 47500) /Hydro	16.5	055	June 4

TABLE #2a (Cont'd)

Site	MAP I.D.	Location and UTM Co-ordinates	Distance (km)	Bearing (DGS)	Date/1979
17.	M	Town of Renton (05637 - 47453) / Hydro	15	290	June 6
18.	D	Explorer Hotel (05730 - 47483) /Hydro	10.5	335	June 6
19.	N	Hwy. #40 near Fisherville Rd. (05882 - 47518) /Hydro	16	040	June 7
20.	O	Hwy. #26 1Km E. Dry Lake Rd. (05869 - 47558) /Hydro	19	030	June 7
21.	P	Bridge in the Town of York (05903 - 47635) /Hydro	27	030	June 7
22.	D	Explorer Hotel (05730 - 47483) /Hydro	10.5	335	June 8
23.	Q	Hwy. #40 & Fisherville Rd. (05883 - 47517) /Hydro	17	040	June 8
24.	D	Explorer Hotel (05730 - 47483) /Hydro	10.5	335	June 8
25.	R	Conc. #3 1.5 km E. of Nanticoke Rd. (05779 - 47436) /Txco.	1.5	320	June 9
26.	D	Explorer Hotel (05730 - 47483) /Hydro	10.5	335	June 9
27.	D	Explorer Hotel (05730 - 47483) /Hydro	10.5	335	June 10
28.	D	Explorer Hotel (05730 - 47483) /Hydro	10.5	335	June 11
29.	S	Conc. #2, NW of NGS (05770 - 47418) /Txco	2	260	June 12
31.	T	Conc #2, N. of NGS (05773 - 47419) /Txco	1.5	260	June 12
32.	T	Conc #2, N. of NGS (05773 - 47419) /Txco	1.5	260	June 12
33.	N	Hwy. #40 & Conc. #8 (05876 - 47519) /Hydro	16	040	June 13

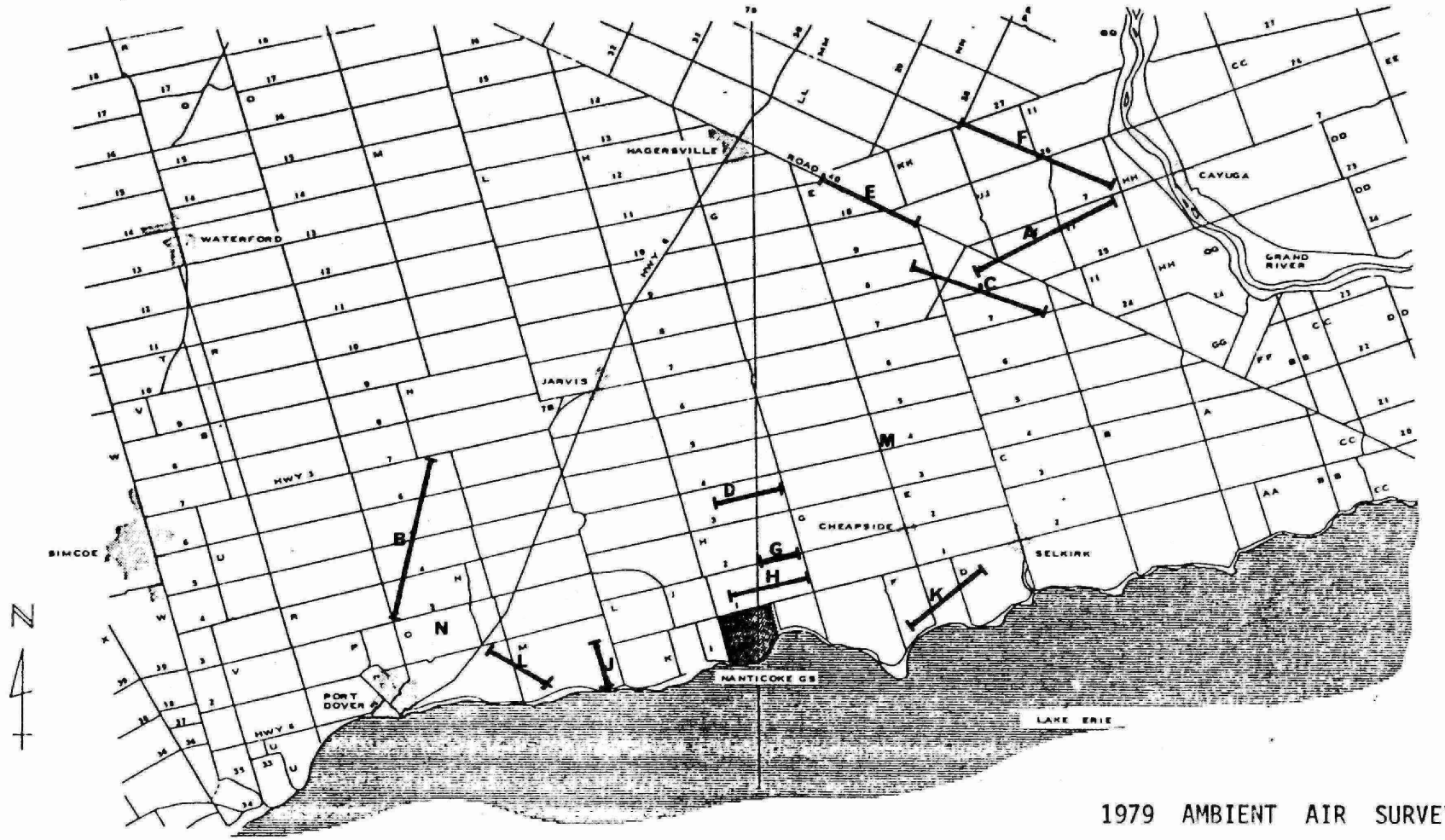
TABLE #2a (Cont'd)

Site	MAP I.D.	Location and UTM Co-ordinates	Distance (km)	Bearing (DGS)	Date
34.	U	Hwy. #54, 2km N. Cayuga (05925 - 47575) /Hydro	23	040	June 13
37.	V	Hwy. #3 & Dry Lake Rd. (05865 - 47534) /Hydro	16	030	June 14
38.	W	Cayuga Courthouse on Hwy. #54 (05931 - 47463) /Hydro	23	040	June 14

TABLE #2b
G.C. Monitoring Sites
Sampling by MAM Unit - direct injection method
(Refer to Map #2)

Vicinity	Sample #	MAP I.D.	Location	Date (1979)
Downwind Hydro	17	C	Conc. #4 & Selkirk Rd.	May 29
Downwind Hydro	18	C	Conc. #4 & Selkirk Rd.	May 29
Downwind Hydro	19	C	Conc. #4 & Selkirk Rd.	May 29
Downwind Hydro	32	E	Hwy. #3, 1.3 km E Sandusk Rd.	May 30
Downwind Hydro	33	E	Hwy. #3, 1.3 km E Sandusk Rd.	May 30
Downwind Hydro	34	F	Conc. #11, 100 m W. Hwy. #6	May 30
Downwind Hydro	35	F	Conc. #11, 100 m W. Hwy. #6	May 30
Downwind Texaco	1	A	Conc. #3, 0.3 km W. Sandusk Rd.	May 28
Downwind Texaco	2	A	Conc. #3, 0.3 km W. Sandusk Rd.	May 28
Downwind Texaco	3	A	Conc. #3, 0.3 km W. Sandusk Rd.	May 28
Downwind Texaco	4	A	Conc. #3, 0.3 km W. Sandusk Rd.	May 28
Downwind Texaco	5	A	Conc. #3, 0.3 km W. Sandusk Rd.	May 28
Downwind Texaco	6	A	Conc. #3, 0.3 km W. Sandusk Rd.	May 28
Downwind Texaco	31A	D	Explorer Hotel	May 30
Downwind Texaco	63	A	W. of Sandusk Rd., Conc. #3	June 3
Downwind Texaco	74	X	300 m W. of Sandusk Rd. Conc. #4	June 7
Downwind Texaco	103	S	Conc. #2, 3 km from Texaco	June 12
Downwind Texaco	104	S	Conc. #2, 3 km from Texaco	June 12
Downwind Texaco	105	T	Conc. #2, 1.5 km from Texaco	June 12
Downwind Texaco	106	T	Conc. #2, 1.5 km from Texaco	June 12
Downwind Texaco	107	T	Conc. #2, 1.5 km from Texaco	June 12
Upwind	61	Y	Conc. #1, 1.1 km E Nanticoke Rd.	June 3
Upwind	62	Y	Conc. #1, 1.1 km E Nanticoke Rd.	June 3

MAP # 3

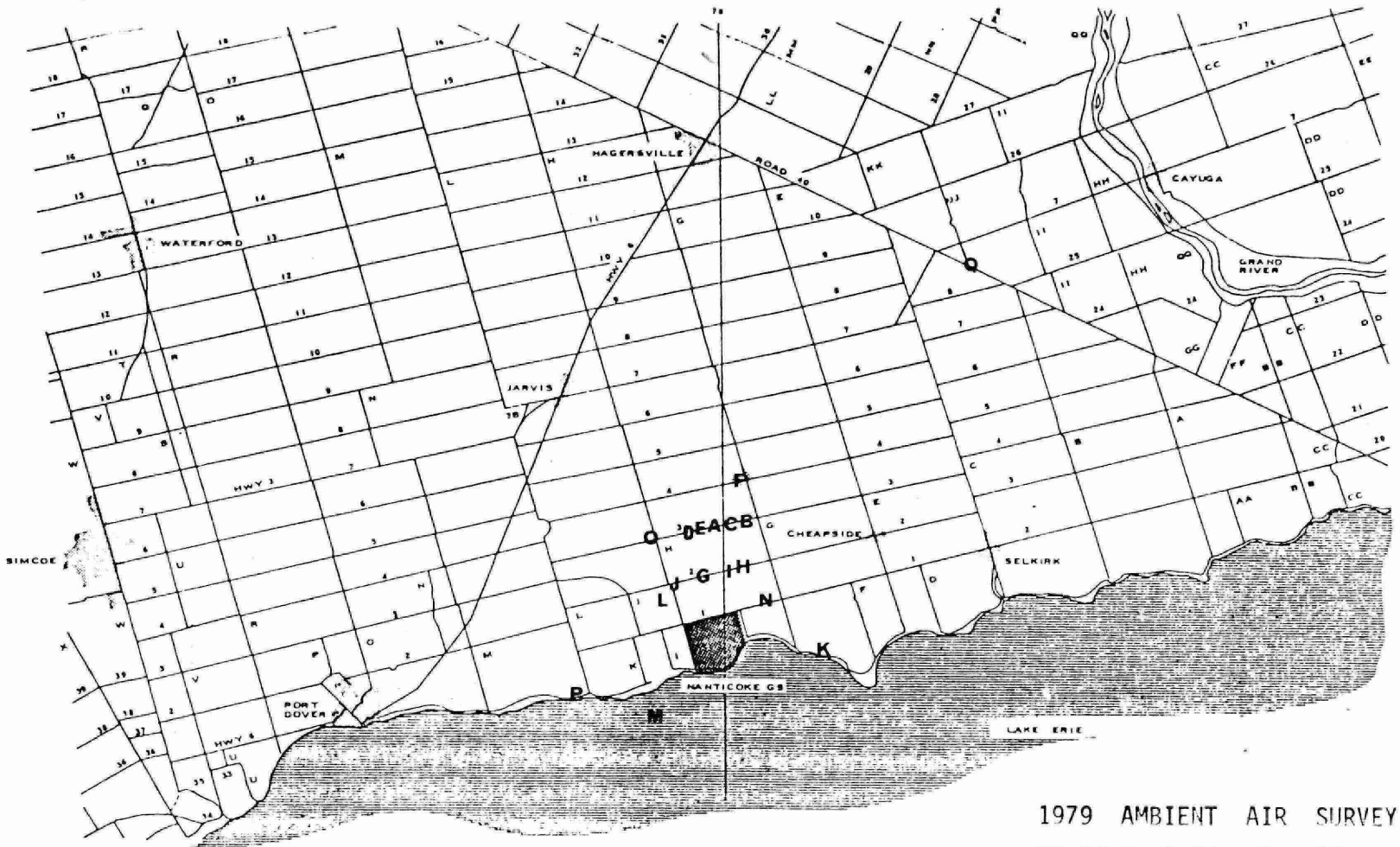


1979 AMBIENT AIR SURVEY
Airborne Cartridge
Sampling Sites

NANTICOKE GS – AIR POLLUTION SURVEY AREA

TABLE #3
G.C. Monitoring Sites
Airborne Cartridge Sampling
(Refer to Map #3)

Vicinity	Sample #	MAP I.D.	Location	Altitude (ft)	Date (1979)
Hydro Plume	58	A	Between Nelles Corners & Cayuga	from 300-900	June 4
Hydro Plume	76	B	North of Port Dover	from 300-1300	June 6
Hydro Plume	77	C	Between Conc. #8 & Selkirk Rd. to Conc. #7 & Fisherville Rd.	from 300-900	June 7
Hydro Plume	154	E	Along Hwy. #40, between Hagersville & Nelles Corner	from 300-900	June 14
Hydro Plume	156	F	5 km NE of Hwy. #40		June 14
Texaco Plume	7	G	Border of Texaco plant	70	May 28
Texaco Plume	9	G	Border of Texaco plant	150	May 28
Texaco Plume	111	H	N. Conc. #1 between Nanticoke & Sandusk Rd.	75	June 12
Texaco Plume	112	H	N. Conc. #1 between Nanticoke & Sandusk Rd.	150	June 12
Texaco Plume	113	H	N. Conc. #1 between Nanticoke & Sandusk Rd.	500	June 12
Upwind of Industrial Complex	8		Upwind of Texaco	300	May 28
Upwind	22	J	Near Stelco	250	May 29
Upwind	23	J	Near Stelco	250	May 29
Upwind	82	K	Between Peacock Pt. & Selkirk	1000	June 6
Upwind	110	D	S. of Conc. #4 between Nanticoke Rd. & Sandusk Rd.	75	June 12
Upwind	114	D	S. of Conc. #4 between Nanticoke Rd. & Sandusk Rd.	150	June 12
Upwind	139	L	Between N. of Nanticoke & E of Port Dover	900	June 13
Exhaust	21	M	Circle, N.E. of Hydro's Dry Creek Station (Conc. #4, E. of Cheapside Rd.)	200	May 29
Exhaust	38	N	Circle, N.E. of Port Dover	1000	May 30


HAGERSVILLE
ROAD 20
CAYUGA
WATERFORD
GRAND RIVER
JARVIS
HWY 3
HWY 6
SIMCOE
CHEAPSIDE
SELKIRK
PORT DOVER
NANTICOKE GS
LAKE ERIE
P
O
D
E
A
C
B
G
H
J
L
N
K
M
Q
N
SCALE
MILES
KILOMETERS
Long Point Park
38 km from
Nant. GS
NANTICOKE GS – AIR POLLUTION SURVEY AREA
1979 AMBIENT AIR SURVEY
Field Cartridge Sampling
Sites

MAP # 4

TABLE # 4
G.C. Monitoring Sites
Field Cartridge Samples
(Refer to Map #4)

Vicinity (Nanticoke Industrial Complex)	Sample #	MAP I.D.	Location	Date
Downwind	11	A	N. of Texaco on Conc. #3	May 28
Downwind	12	A	N. of Texaco on Conc. #3	May 28
Downwind	27	B	Conc. #3, 300 m NE of Texaco	May 29
Downwind	28	B	Conc. #3, 300 m of NE of Texaco	May 29
Downwind	41	C	Conc. #3, 2.75 km E Nanticoke Rd.	May 30
Downwind	42	D	Conc. #3, 1.5 km E. Nanticoke Rd.	May 30
Downwind	50	E	Conc. #3, 2 km E Nanticoke Rd.	June 1
Downwind	51	E	Conc. #3, 1.7 km E Nanticoke Rd.	June 1
Downwind	52	B	Conc. #3, .6 km W Sandusk Rd.	June 3
Downwind	53	B	Conc. #3, .6 km W Sandusk Rd.	June 3
Downwind	54	B	Conc. #3, .6 km W Sandusk Rd.	June 3
Downwind	55	E	Conc. #3, 2.1 km E Nanticoke Rd.	June 4
Downwind	65	I	Conc. #2, 2 km E Nanticoke Rd.	June 5
Downwind	67	I	Conc. #2, 2 km E Nanticoke Rd.	June 5
Downwind	69	I	Conc. #2, 2 km E Nanticoke Rd.	June 5
Downwind	71	E	Conc. #3, 1.8 km E Nanticoke Rd.	June 7
Downwind	72	E	Conc. #3, 2 km E Nanticoke Rd.	June 7
Downwind	73	F	Conc. #4, 100 m W Sandusk Rd.	June 7
Downwind	78	E	Conc. #3, 1.8 km E Nanticoke Rd.	June 8
Downwind	79	B	Conc. #3, 300 m W Sandusk Rd.	June 8
Downwind	80	B	Conc. #3, 300 m W Sandusk Rd.	June 8
Downwind	81	E	Conc. #3, 1.8 km E Nanticoke Rd.	June 8
Downwind	89	E	Conc. #3, 1.8 km E Nanticoke Rd.	June 10
Downwind	90	E	Conc. #3, 1.9 km E Nanticoke Rd.	June 10
Downwind	91	E	Conc. #3, 1.8 km E Nanticoke Rd.	June 10
Downwind	92	D	Conc. #3, 1.6 km E Nanticoke Rd.	June 10
Downwind	96	E	Conc. #3, 1.8 km E Nanticoke Rd.	June 10
Downwind	98	D	Conc. #3, 1.6 km E Nanticoke Rd.	June 10
Downwind	99	E	Conc. #3, 1.8 km E Nanticoke Rd.	June 10
Downwind	100	D	Conc. #3, 1.6 km E Nanticoke Rd.	June 9
Downwind	101	D	Conc. #3, 1.6 km E Nanticoke Rd.	June 10
Downwind	115	G	Conc. #2, 1.6 km E Nanticoke Rd.	June 12
Downwind	116	G	Conc. #2, 1.6 km E Nanticoke Rd.	June 12
Downwind	117	H	Conc. #2, 1 km W Sandusk Rd.	June 12
Downwind	118	H	Conc. #2, 1 km W Sandusk Rd.	June 12
Downwind	119	G	Conc. #2, 1.8 km E Nanticoke Rd.	June 12
Downwind	120	G	Conc. #2, 1.8 km E Nanticoke Rd.	June 12
Downwind	121	I	Conc. #2, 2.3 km E Nanticoke Rd.	June 12
Downwind	122	I	Conc. #2, 2.3 km E Nanticoke Rd.	June 12
Downwind	123	G	Conc. #2, 1.6 km E Nanticoke Rd.	June 12
Downwind	124	G	Conc. #2, 1.6 km E Nanticoke Rd.	June 12
Downwind	125	H	Conc. #2, 1 km W Sandusk Rd.	June 12
Downwind	126	H	Conc. #2, 1 km W Sandusk Rd.	June 12
Downwind	127	G	Conc. #2, 1.8 km E Nanticoke Rd.	June 12
Downwind	128	I	Conc. #2, 2.3 km E Nanticoke Rd.	June 12
Downwind	129	I	Conc. #2, 2.3 km E Nanticoke Rd.	June 12

TABLE #4 (Cont'd)

Vicinity (Nanticoke Industrial Complex)	Sample #	MAP I.D.	Location	Date (1979)
Downwind	130	I	Conc. #2, 2.3 km E Nanticoke Rd.	June 12
Downwind	131	I	Conc. #2, 2.3 km E Nanticoke Rd.	June 13
Downwind	132	I	Conc. #2, 2.3 km E Nanticoke Rd.	June 13
Downwind	135	I	Conc. #2, 2.3 km E Nanticoke Rd.	June 13
Downwind	136	I	Conc. #2, 2.3 km E Nanticoke Rd.	June 13
Downwind	145	A	Conc. #3, 2.1 km E Nanticoke Rd.	June 14
Downwind	146	A	Conc. #3, 2.1 km E Nanticoke Rd.	June 14
Downwind	147	A	Conc. #3, 2.1 km E Nanticoke Rd.	June 14
Downwind	148	A	Conc. #3, 2.1 km E Nanticoke Rd.	June 14
Downwind	149	A	Conc. #3, 2.1 km E Nanticoke Rd.	June 14
Downwind	152	A	Conc. #3, 2.1 km E Nanticoke Rd.	June 14
Downwind	153	A	Conc. #3, 2.1 km E Nanticoke Rd.	June 14
Upwind	14	J	SW of Texaco, Conc. #2	May 28
Upwind	15	B	NE of Texaco, Conc. #3	May 28
Upwind	25	J	Conc. #2, SW Texaco, 4m from Nanticoke Rd.	May 29
Upwind	29	K	Haldiman Park, Lake Erie	May 29
Upwind	30	L	Near Nanticoke Rd., ½ km S. Conc. #2	May 29
Upwind	31B	M	End of Stelco Pier	May 29
Upwind	40	G	Conc. #2, 1.5 km E Nanticoke Rd.	May 30
Upwind	49	G	Conc. #2, 1.8 km E Nanticoke Rd.	June 1
Upwind	56	C	Conc. #3, 2.7 km E Nanticoke Rd.	June 4
Upwind	57	N	Conc. #1, 3 km E Nanticoke Rd.	June 4
Upwind	68	O	Conc. #3, & Nanticoke Rd.	June 5
Upwind	85		Long Point Park (approx 05490-47140 UTM co-ordinates)	June 6
Upwind	86		Long Point Park (approx 05490-47140 UTM co-ordinates)	June 6
Upwind	87		Long Point Park (approx 05490-47140 UTM co-ordinates)	June 6
Upwind	133		Long Point Park (approx 05490-47140 UTM co-ordinates)	June 13
Upwind	134		Long Point park (approx 05490-47140 UTM co-ordinates)	June 13
Upwind	137		Long Point Park (approx 05490-47140 UTM co-ordinates)	June 13
Upwind	138		Long Point Park (approx 05490-47140 UTM co-ordinates)	June 13
Upwind	141	G	Conc. #2, 1.7 km E. Nanticoke Rd.	June 14
Upwind	142	G	Conc. #2, 1.7 km E. Nanticoke Rd.	June 14
Upwind	143	G	Conc. #2, 1.7 km E. Nanticoke Rd.	June 14
Upwind	144	G	Conc. #2, 1.7 km E. Nanticoke Rd.	June 14
Upwind	150	G	Conc. #2, 1.7 km E. Nanticoke Rd.	June 14
Upwind	151	G	Conc. #2, 1.7 km E. Nanticoke Rd.	June 14

TABLE #4 (Cont'd)

Vicinity	Sample #	MAP I.D.	Location	Date (1979)
Downwind of Gaswells	43	P	Lakeshore Rd., 1km W. of Stelco, at creek	May 31
Downwind of Gaswells	44	P	Lakeshore Rd., 1km W. of Stelco	May 31
Downwind of Gaswells	45	Q	HWY #40 & Dry Lake Rd.	May 31
Downwind of Gaswells	47	Q	HWY #40 & Dry Lake Rd.	June 2
Downwind of Gaswells	48	Q	HWY #40 & Dry Lake Rd.	June 2
Downwind of Pipelines *	108	I	10 m W. of pipelines Conc. #2, 2.3km E. of Nanticoke Rd.	June 12
Downwind of Pipelines	109	I	10 m W. of pipelines Conc. #2 2.3 km E. of Nanticoke Rd.	June 12

* Pipelines originating from the Texaco refinery

07. Results

Definition of Terms

Scan Time: Time interval for averaging and data logging of instantaneous interrogations by the data acquisition system of the monitoring instruments.

Time: Time of the first and final scans used to determine running averages.

Number of Readings: Number of Scans
MAM: Mobile Air Monitoring
glc: ground level concentration

All statistical values are based on cumulative averages of continuous instantaneous interrogations of the monitoring instruments and all results are expressed in parts per million (ppm). An example of the processed data format incorporated in this survey report is presented in Table #5, page 28. Due to the large quantity of data, time averages will be included in the addendum entitled, "Ambient Air Survey in the Nanticoke Area, May-June 1979, Compilation of Time Averaged Data", which will accompany this report and will be presented upon request.

The statistical summary of the collected data is presented in Tables #6, #7, and #8, pages 78 through 86. Supplementing these tables, concentration versus time graphs are presented in Figures #2 through #14, pages 44 through 56.

Correlation statistics of the various pollutants are also presented (Figures #15 to #26, pages 57 through 68) in order to assist in the determination of source identification and to investigate possible atmospheric chemical activity.

Also, to aid in source identification for monitoring period #21, a wind rose/concentration analyses was plotted on Map #5, page 74.

A breakdown of the classifications used to analyze the hydrocarbon data is presented in the flow chart (Figure #1, page 29). The results of this data are presented in Table #9, pages 87 through 105. The values are presented in units of parts per billion (ppb).

In order to assess whether breakthrough occurred, correlations comparing certain hydrocarbon concentrations at different flowrates are presented in Figures #27 to #31 pages 69 to 73.

TABLE #5

Processed Data Format

Nanticoke III #7

(Further Analyses are Presented as an Addendum)

NANTICOKE III #7

DATE: MAY 30 1979
SCAN TIME: 60 SEC
AVERAGING TIME: 30 MIN
LOCATION: HWY #40, 0.5KM NW HWY#6(05770-47570); 18KM & 355DGS/HYDRO

TIME	CO THC-CH4 NO HUMIDITY	H2S CH4 OZONE WIND SPEED	THC NOX SOLAR RAD WIND DIRECTION	SO2 NO2 TEMP
16:50----17:20	4.0E+00 2.3E-01 1.6E-02 52	1.6E-03 1.2E+00 4.7E-02 12	1.4E+00 3.2E-02 4.5E-02 227	3.5E-02 2.0E-02 21
16:56----17:26	3.5E+00 2.3E-01 1.3E-02 52	1.7E-03 1.2E+00 4.7E-02 12	1.4E+00 2.8E-02 3.8E-02 226	3.2E-02 1.7E-02 21
17:02----17:32	3.4E+00 2.3E-01 1.4E-02 51	1.8E-03 1.2E+00 5.0E-02 12	1.4E+00 2.5E-02 3.1E-02 225	2.4E-02 1.4E-02 22
17:08----17:38	4.1E+00 2.1E-01 2.2E-02 51	1.7E-03 1.2E+00 5.2E-02 12	1.4E+00 2.5E-02 2.4E-02 221	1.7E-02 9.8E-03 22

STATISTICS

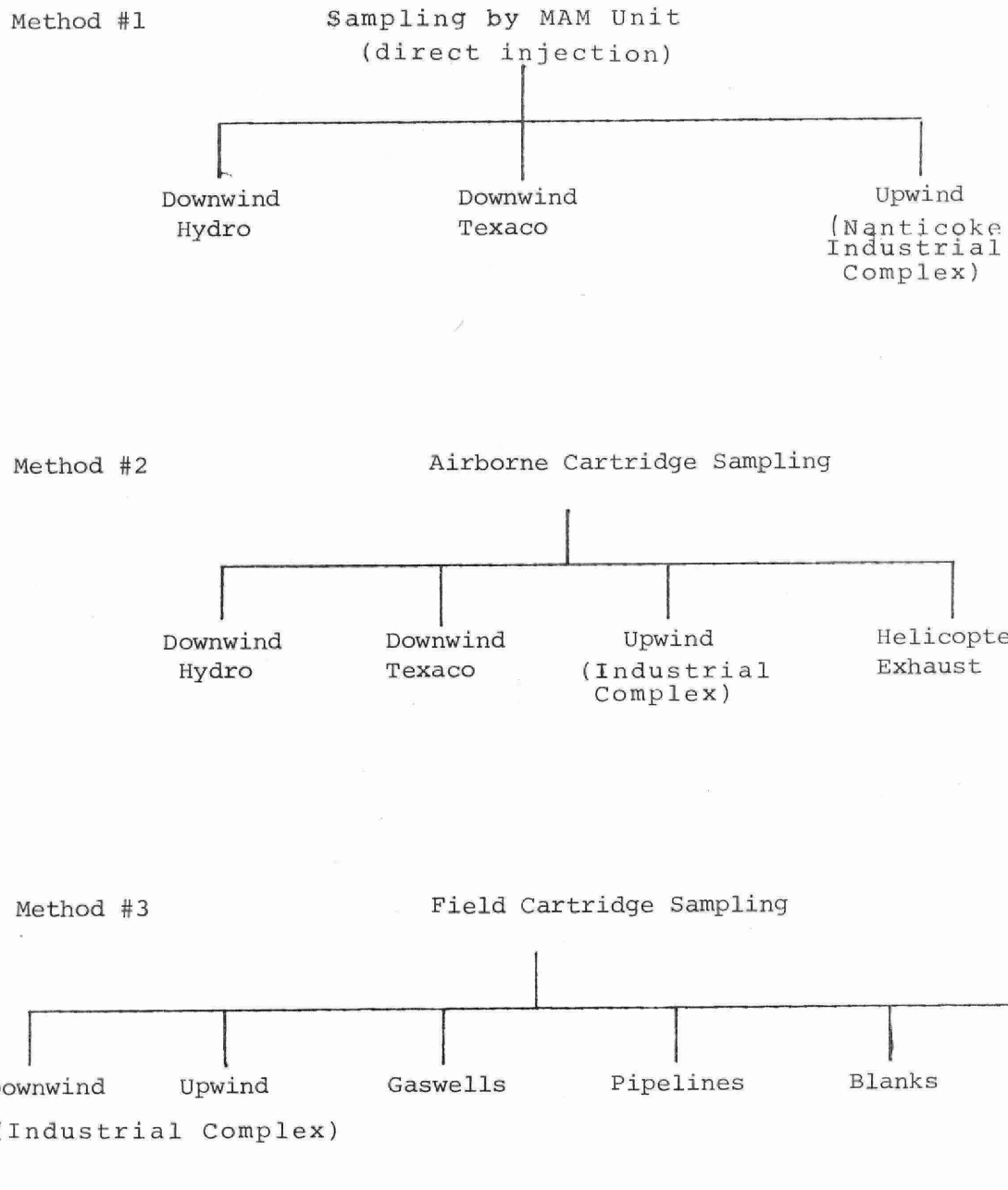
NUMBER OF READINGS 51

POLLUTANT	MINIMUM VALUE	MAXIMUM VALUE	ARITHMETIC MEAN	STANDARD DEVIATION	GEOMETRIC MEAN	GEOMETRIC STD. DEV.
CO	1.85E+00	1.54E+01	4.34E+00	2.22E+00	3.95E+00	1.52E+00
H2S	6.58E-04	2.50E-03	1.59E-03	4.90E-04	1.51E-03	1.40E+00
THC	1.35E+00	1.65E+00	1.41E+00	4.54E-02	1.41E+00	1.03E+00
SO2	1.17E-02	7.00E-02	2.66E-02	1.57E-02	2.31E-02	1.68E+00
THC-CH4	1.89E-01	3.20E-01	2.20E-01	3.27E-02	2.18E-01	1.14E+00
CH4	1.09E+00	1.19E+00	1.18E+00	2.01E-02	1.18E+00	1.02E+00
NOX	1.00E-06	8.25E-02	3.15E-02	1.76E-02	1.93E-02	7.96E+00
NO2	1.00E-06	6.39E-02	1.42E-02	1.38E-02	1.29E-03	7.31E+01
NO	3.06E-03	8.38E-02	2.30E-02	2.22E-02	1.45E-02	2.66E+00
OZONE	3.38E-02	5.52E-02	4.90E-02	5.68E-03	4.87E-02	1.13E+00
SOLAR RAD	1.33E-02	5.30E-02	3.25E-02	1.59E-02	2.82E-02	1.76E+00
TEMP	20	22	21	1		
HUMIDITY	46	61	51	2	51	1
WIND SPEED	8	18	12	2	12	1

Figure #1

Nanticoke Hydrocarbon

Survey Summary



08. Discussion

Ambient air monitoring of ground-level concentrations (glc) of gaseous pollutants by the MAM unit was carried out during 16 days in the time period May 28th to June 14th, 1979. During this period, approximately 163 hours of data were collected at 34 different monitoring sites. As well as the data collected by the instrumentation associated with the MAM unit, airborne and ground-level samples of ambient air were collected in cartridges, to be later analyzed by gas chromatographic techniques for specific hydrocarbon content.

Ground-level concentration measurements of gaseous pollutants within impingement zones as defined below, were the main aims of this study. The stable lake air, is advected inland by lake breeze/on-shore flows and is modified by surface heating. This forms a mixing layer (called Thermal Internal Boundary Layer -TIBL) over the land. Elevated coastal plumes (an example being the Nant. GS plume) travel inland with very little dispersion in the stable layer aloft until they intersect the edge of the TIBL. At this point the convective turbulence of the underlying unstable air causes fumigation of the plumes producing high glc's.

In the Nanticoke area, the terrain is essentially flat and void of any large geographical stuctures. The geographical as well as the meteorological conditions which prevailed during this time period, produced conditions which were favourable to the formation of well defined TIBL's during the afternoons and discreet fumigation zones resulted.

It should be stated that the bulk of the observed elevated glc's reported may be directly attributed to the emissions originating from the Nanticoke industrial complex.

The positions of these fumigation zones were first determined by the other

groups involved with this study and this information was then relayed to the MAM unit. Monitoring at these zones was initiated as soon as possible. Because of this time delay, several monitoring periods did not span the complete fumigation period.

The following are the Standards, based on a 30-minute average glc of gaseous pollutants, as set out in Schedule 1, Regulation 15 of the Ontario Environmental Protection Act.

Pollutant	Standard(1)
SO_2	0.30 parts per million (ppm)
H_2S	0.02 ppm (2)
NOx	0.27 ppm (3)
0_3	0.10 ppm
THC	(4)

1. Conversion from ug/m^3 to ppm was made under the following conditions; temperature: 298°K (25°C) and atmospheric pressure 101.6 k Pa.

2. This instrument was also sensitive to other reduced sulphur compounds. However, as dictated by the source emissions, H_2S was assumed to be the major gaseous component and the results were reported accordingly.

3. Expressed as concentrations of NO_2.

4. At this time, there exists no Standard nor Criteria for total hydrocarbons.

Sulphur Dioxide - SO_2

One of the more important compounds monitored during the survey was sulphur dioxide, since it is one of the major pollutants emitted by coal-fired generating stations.

For all the reported monitoring periods, the overall average concentration of SO_2 was 0.05 ppm with an associated standard deviation of 0.06 ppm, which was identical to the results found in the 1978 survey (refer to ARB-TDA Report No. 54-78). A summary of the statistical results for this gaseous pollutant is presented in Table #6, pages 78 to 80.

The maximum instantaneous glc of SO_2 was 0.55 ppm and this value was recorded during monitoring period #37 on June 14th. (Even though this monitoring period of 44 minutes duration was just short of the minimum required observation period, the resulting 30-minute average glc was deemed a true average indicative of the impingement). Also, on this occasion only, the Standard was exceeded. This maximum value was 0.33 ppm. The MAM unit was located 16 km downwind of the Nant. GS for this period. The winds were on the average, 20 km/hr from the south. It is quite possible that the maximum value was even larger than the concentration of SO_2 reported due to the time delay of setting up the MAM unit after the fumigation zone was located by the other investigative groups associated with this study. The concentration/time graph of period #37 (Figure #9, page 51) shows a gradual decrease of concentration with time, consistent with the above supposition.

Instantaneous glc's of SO_2 as high as 0.30 ppm were recorded on two occasions (monitoring periods #20 and #22 represented in Figures #6 and 8 on pages 48 and 50). During monitoring period #20, a classic fumigation period was monitored. The concentration/time graph (Figure #6 page 48) showed the gradual buildup and dissipation of ground level concentrations of SO_2 at this site. The wind direction was southwest at about 14km/hr and because of the location of the MAM unit, the Nant. GS was determined to be a possible source of this contaminant.

Monitoring period #21 (figure #7, page 49) also showed a high maximum instantaneous concentration of SO_2 (0.267 ppm) even though the MAM unit was located 27 km downwind of the Nant. GS in the town of York. This situation is most likely due to a fumigation as a result of the TIBL. The monitoring period was late afternoon when the sun's intensity was decreasing. Because of this, the height of the TIBL probably decreased, causing the plume to travel farther downwind before intersecting the TIBL.

In order to assist in source identification, a wind rose/concentration analysis was performed for this monitoring period (See Map #5, page 74). The resulting plot indicates a source to the south of the town of York. Since the measurement of the wind is a localized parameter, recorded at the site of the MAM unit, the source of the high glc's being the Nanticoke industrial complex is a reasonable assumption.

Oxides of Nitrogen - NOx

Other important gaseous pollutants monitored during this survey were the oxides of nitrogen which include NO and NO_2. For all the reported monitoring periods, the overall average glc of N0x at the points of impingement was 0.031 ppm with an associated standard deviation of 0.034 ppm. During the 1978 survey the overall average glc was 0.037 ppm with an associated standard deviation of 0.22 ppm.

Although the 30-minute average glc for N0x did not exceed the Standard at any time during the survey, instantaneous values in excess of 0.27 ppm were observed on occasion, with the highest concentration being 0.878 ppm.

The largest maximum 30-minute average glc of NOx was detected during monitoring period #4 on May 30th, its value being 0.20 ppm. (See Figure #3, page 45). The winds were essentially calm from the north and the MAM unit was located approximately 10.5 km downwind from the Nant. GS at the southwest corner of the Explorer Hotel. From a comparison of the ratios NO/NO_x and NO_2/NO_x, of the 30 minute average glc for this time, the majority of the NO_x concentration was due to the NO component (60%). Due to the very light winds recorded, this suggested that the major source of this high NO_x concentration could have been vehicular emissions.

A very strong positive correlation between NOx and SO_2 was found during this monitoring period and is shown in Figure #15, page 57. The correlation coefficient was 0.638 which was highly significant (at the 99% confidence level). This correlation persisted throughout the entire survey, strongly suggesting the same source as the SO_2. See also Figures #16 and 17, pages 58 and 59 for monitoring periods #20 and 37. Both of these show very strong correlations at the 99.9% confidence level. Thus, in addition to vehicular exhaust, the Nant. GS was considered a possible source of this gaseous pollutant.

Monitoring of the Texaco emissions, as determined by the close location of the MAM unit to the source, was undertaken during monitoring periods # 1, 12, 29, 31 and 32. For SO_2, the overall average glc was O.O1 ppm with an associated standard deviation of O.O3 ppm. NO_x had an overall average glc of O.O2 ppm and a standard deviation of O.O2 ppm. Because of these low concentrations, the contributions to the pollutants SO_2 and NO_x from Texaco were minimal.

Hydrogen Sulphide - H_2S

The analyzer used to measure the H_2S glc's was also sensitive to other reduced sulphur compounds. However, as dictated by the source emissions, H_2S was assumed to be the major gaseous component and the results were reported accordingly.

For all the reported monitoring periods, the overall average glc of H_2S was 0.002 ppm with an associated standard deviation of 0.001 ppm. The survey in 1978 showed an overall average and standard deviation of 0.009 ppm and 0.006 ppm respectively.

Generally speaking, low concentrations of H_2S were found throughout this survey. The largest maximum 30-minute average glc of H_2S was 0.017 ppm which was recorded during monitoring period #27 (See Figure #10 page 52). The MAM unit was located at the Explorer Hotel during this time. This high concentration was most likely due to residual calibration effects; 45 minutes should separate the calibration and monitoring operational modes. There was a definite lack of correlation between H_2S and SO_2 for this period as well as for many others which suggested that Nant. GS was not the source. Other possibilities included seepage from local gas wells and/or long range mass transport from the N or SW.

The correlation plot for monitoring period #37 does show a significant correlation between H_2S and SO_2 (see Figure #20, page 62), but, due to the background concentration levels observed throughout the entire survey and because of the type of chemical processes involved, Nant. GS was not assumed to contribute significantly to H_2S concentrations.

Total Hydrocarbons - THC

Oil refining is a significant potential source of hydrocarbon emissions. Also, hydrocarbons play an important role in atmospheric photochemical reactions.

Low concentrations of this group of gaseous pollutants were detected throughout this survey, of which the overall average glc of THC was 1.55 ppm with an associated standard deviation of 0.84 ppm.

The highest maximum half-hour average concentration of THC was recorded at monitoring site #12 on June 3 and its value was 5.5 ppm (see Figure #12, page 54). During this period, the highest instantaneous concentration was also reported (23.3 ppm). The Texaco plume was being monitored at this time. The MAM unit was located 5.5 km downwind of the refinery.

Throughout the survey, the non-methane component of the total hydrocarbons reported low glc's with an overall average concentration of 0.36 ppm and associated standard deviation of 0.39 ppm. From the above, methane was found to contribute 75% of the THC concentration. Therefore, the major hydrocarbon source in this area was deemed to be non-anthropogenic or of a biological origin.

Ozone - O_3

All reported glc's of O_3 were relatively high throughout the entire survey. The overall average glc of O_3 was 0.058 ppm with an associated standard deviation of 0.053 ppm. In comparison for 1978, the survey reported an overall average of 0.047 ppm with 0.023 ppm as the standard deviation. The 1978 results were lower and not as variable.

During monitoring periods #1, #9, and #10, the O_3 Standard was reached or exceeded (see Figures #2, 4 and 5, pages 44, 46 and 47). It is most likely that background concentrations were being monitored, as there were no known primary sources of O_3 in the vicinity. During monitoring period #1, the maximum 30-minute average glc of O_3 (0.380 ppm) was reported.

Many monitoring periods showed strong negative correlation statistics between O_3 and NOx (see Figures #21 and 22, pages 63 and 64). This illustrates the fact that NOx acts as a sink for the O_3. The data for NO_x, NO and O_3 were combined for all monitoring periods and are shown in Figure #14, page 56. From this data, a correlation plot of NO_x versus O_3 was done (Figure #26 page 68) and the resulting correlation coefficient was -0.02. This slightly negative result shows that generally, the NO_x concentrations were low and therefore, NO_x and O_3 were essentially in an equilibrium state.

The correlation statistics between SO_2, THC and H_2S versus O_3 depicted no relationship (see Figures #23, 24, 25 on pages 65 to 67), and hence, no positive source indentification for ozone could be made. It is very likely that the cause of high glc's of O_3 in the Nanticoke area was of extraneous origin.

Hydrocarbons - G.C. Analysis

Geometric means and standard deviations were used in the statistical interpretation of the hydrocarbon analytical results. The statistical treatment of the hydrocarbon data involved pooled estimates based on the groupings shown in Figure #1, pg. 29. The concentrations appearing in Tables #9 and 10 were all corrected for background levels. Background was determined from unexposed cartridges which accompanied the operator during the specific sampling programme. Representative concentrations determined from these cartridges are shown as blanks in these tables.

Ambient air concentrations for acetylene, cyclo-propane, 2,2-dimethylpropane and n-heptane were very limited. Most samples had concentrations below the detectable limit of 1 ppb and therefore, were treated as background. For the remaining hydrocarbons, the geometric means for the different sampling techniques are presented in Table #10, page 106.

For all sampling techniques, ethene, propane and propene, 3-methylbutene, n-hexane, benzene, and toluene, showed no significant differences between the geometric means upwind and downwind of the Nanticoke industrial complex. A fair amount of contamination of ethene (geometric mean of 38 ppb) was found in the blank cartridges. The geometric mean concentrations of propane and propene, 1,3-butadiene and n-hexane downwind of leaking gaswells, were relatively significant. Downwind pipeline concentrations (i.e. pipelines originating from the Texaco refinery), appeared significant for 3-methylbutene, n-hexane, benzene and toluene but, because of the lack of a significant difference between upwind and downwind geometric means near the pipeline, these hydrocarbons were not assumed to have originated from any one source, but exist in background concentration levels.

The results from the direct injection sampling technique, by the MAM unit located downwind of Texaco, showed that the Texaco refinery possibly produced some isobutane, n-butane and n-butene. Although the geometric mean for isobutane (3 ppb) was not significantly different from the upwind mean of 1 ppb, the geometric standard deviation of 4 indicated a single source emission. For n-butane and n-butene the relatively larger geometric mean of 8ppb with associated geometric standard deviation of 3, also suggested the possiblity of a single source as well.

For n-pentane, the field cartridge concentrations downwind of the industrial complex, strongly suggested a single source emission with a geometric standard deviation of 9. However the geometric mean of 5 ppb was not significantly different from that of the upwind concentrations and hence one may conclude that the leaking gaswells and pipelines, which showed high geometric mean concentrations, were the most probable source. (The graphs used to determine the geometric standard deviations under consideration may be found on pages 75 to 77, Figures #32 to 34).

From the airborne sampling technique, the geometric mean of 1,3-butadiene for downwind concentration values (from both Hydro and Texaco plumes) was larger than the upwind geometric mean. This suggested that 1,3-butadiene originated from the industrial complex. As will be discussed later in this section, these values must be taken in a qualitative sense since breakthrough for 1,3-butadiene was suspected. (See correlation plot Figure #30, pg. 72).

Correlation plots were done for ethene, propane and propene, n-pentane, 1,3-butadiene, and n-butane and n-butene, (see Figures #27 to #31, pages 69 to 73), comparing the concentrations found at the 50 and 100 ml/min flow rates. For n-pentane, propane and propene, and n-butane and n-butene, there was good agreement between the two flow rates which implied that no breakthrough occurred. However, for ethene and 1,3-butadiene, (see Figures #27 and #30, page 69 and 72), the agreement between the 50 and 100 ml/min flow rates was not good and insignificant correlation coefficients were found. As a result breakthrough was suspected.

Since sample contamination of ethene and breakthrough for ethene and 1,3-butadiene were evident, results for these hydrocarbons must be regarded as qualitative in nature and possibly not indicative of the true situation. To alleviate the problems mentioned above, the sampling methodology for ethene and 1,3-butadiene should be reviewed with emphasis placed on sample gathering (proper procedure), sample storage (proper media) and mode of presentation to the lab for analysis.

09. Appendix

A. Concentration/Time Graphs:

Monitoring	Period	#1	SO_2, NOx, and O_3	- Figure #2
Monitoring	Period	#4	SO_2, NOx, and O_3	- Figure #3
Monitoring	Period	#9	SO_2, NOx, and O_3	- Figure #4
Monitoring	Period	#10	SO_2, NOx, and O_3	- Figure #5
Monitoring	Period	#20	SO_2, NOx, and O_3	- Figure #6
Monitoring	Period	#21	SO_2, NOx, and O_3	- Figure #7
Monitoring	Period	#22	SO_2, NOx, and O_3	- Figure #8
Monitoring	Period	#37	SO_2, NOx, and O_3	- Figure #9
Monitoring	Period	#27	SO_2, H_2S, and NOx	- Figure #10
Monitoring	Period	#37	SO_2, H_2S, and NOx	- Figure #11
Monitoring	Period	#12	SO_2, H_2S, and THC	- Figure #12
Monitoring	Period	#20	SO_2, H_2S and THC	- Figure #13
All Monitoring Periods Combined			NO, NO_x, and O_3	- Figure #14

B. Correlation Statistics - Graphs:

Monitoring	Period	#4	NOx versus SO_2	- Figure #15
Monitoring	Period	#20	NOx versus SO_2	- Figure #16
Monitoring	Period	#37	NOx versus SO_2	- Figure #17
Monitoring	Period	#20	H_2S versus SO_2	- Figure #18
Monitoring	Period	#27	H_2S versus SO_2	- Figure #19
Monitoring	Period	#37	H_2S versus SO_2	- Figure #20
Monitoring	Period	#20	NOx versus O_3	- Figure #21
Monitoring	Period	#21	NOx versus O_3	- Figure #22
Monitoring	Period	#20	SO_2 versus O_3	- Figure #23
Monitoring	Period	#20	THC versus O_3	- Figure #24
Monitoring	Period	#20	H_2S versus O_3	- Figure #25
All Monitoring Periods			NO_x versus O_3	- Figure #26
Comparison of Flow Rates			Ethene	- Figure #27
			Propane & Propene	- Figure #28
			n-Pentane	- Figure #29
			1,3-Butadiene	- Figure #30
			n-Butane & n-Butene	- Figure #31

C. Wind Rose/Concentration Analyses:

Monitoring	Period	#21	SO_2 and wind dir.	- Map #5

D. Statistical Summary Tables:

SO_2 and NOx concentrations	- Tables #6 a b c
THC and H_2S concentrations	- Tables #7 a b c
O_3 concentrations	- Tables #8 a b c

Hydrocarbon Data analyzed by Gas Chromatograph:

1) Sampling by MAM unit (direct injection)	- TABLES #9 abc
2) Airborne Cartridge Sampling	- TABLES #9 defg
3) Field Cartridge Sampling	- TABLES #9 hijklm
Geometric means for Hydrocarbon Data	- TABLE #10

E. Statistical Summary Graphs:

Geometric Standard Deviations

1) Sampling by MAM unit - Downwind Texaco isobutane	- Figure #32
2) Sampling by MAM unit - Downwind Texaco n-butane and n-butene	- Figure #33
3) Field Cartridge Sampling - Downwind n-pentane	- Figure #34

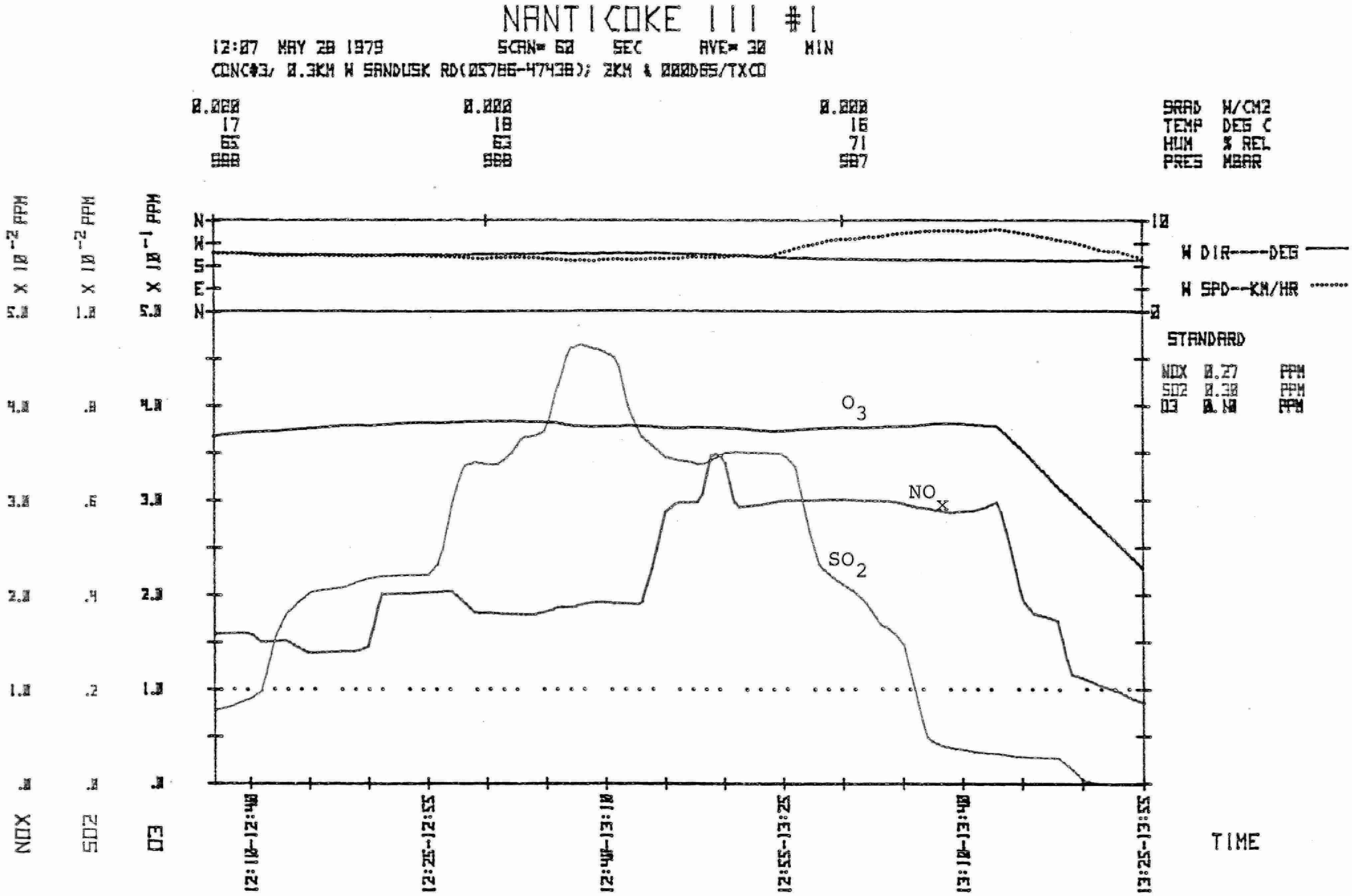

NANTICOKE III #1
12:07 MAY 28 1979 SCAN= 60 SEC AVE= 30 MIN
CONC#3/ 0.3KM W SANDUSK RD(05786-47430); 2KM & 000D65/TXCO
SRAD W/CM2
TEMP DEG C
HUM % REL
PRES MBAR
W DIR----DEG
W SPD--KM/HR
STANDARD
NOX 0.27 PPM
SO2 0.30 PPM
O3 0.10 PPM
O3
NOx
SO2
NOX
SO2
O3
TIME

Figure 2

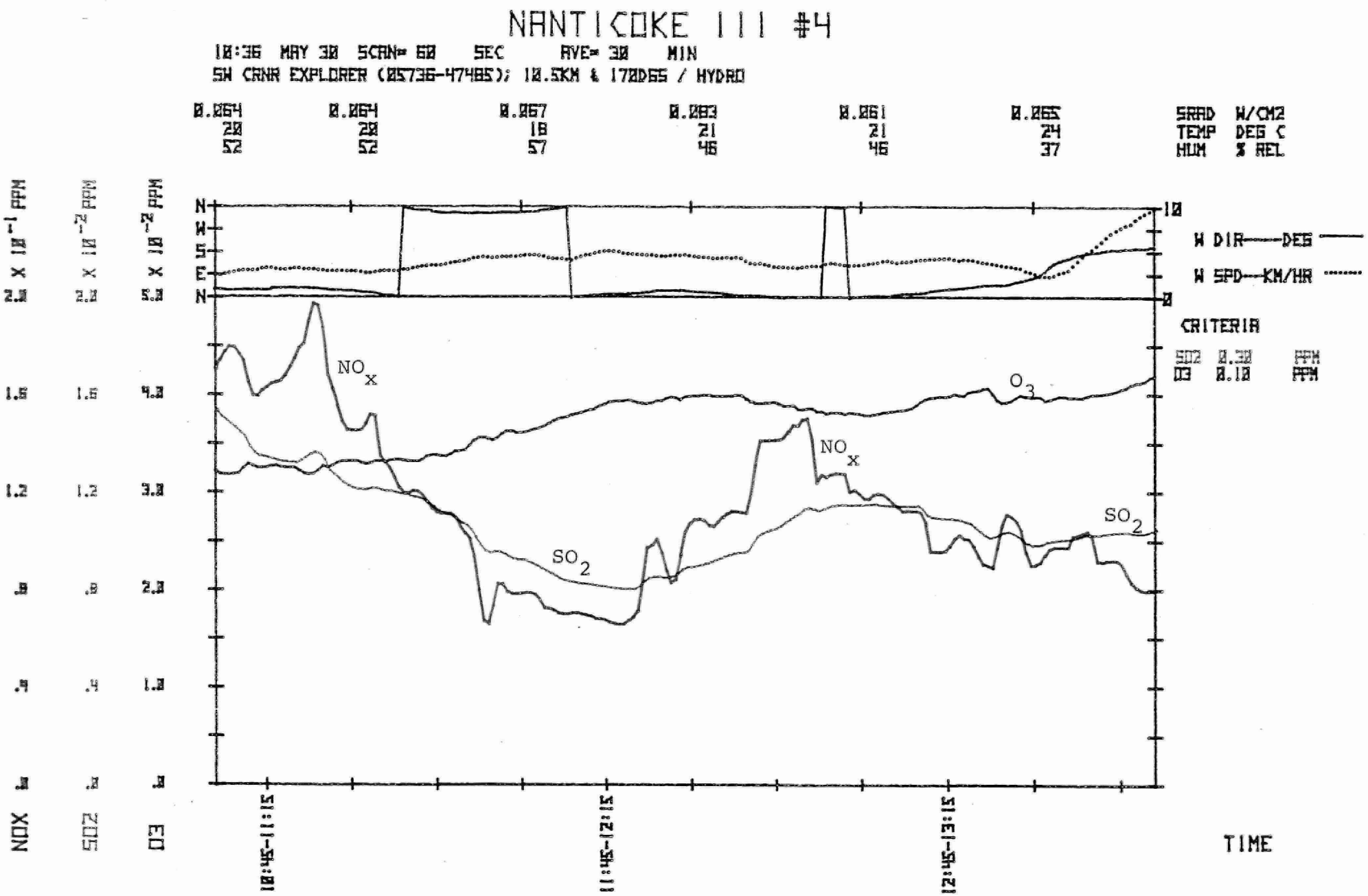

NANTICOKE III #4
10:36 MAY 30 SCAN= 60 SEC AVE= 30 MIN
SW CRNR EXPLORER (05736-47485); 10.5KM & 178DEG / HYDRO
0.064 0.064 0.067 0.083 0.061 0.065 SRAD W/CM2
20 20 18 21 21 24 TEMP DEG C
52 52 57 46 46 37 HUM % REL
2.0 X 10-1 PPM
2.0 X 10-2 PPM
5.0 X 10-2 PPM
NOX
SO2
O3
W DIR——DEG
W SPD---KM/HR
CRITERIA
SO2 0.38 PPM
O3 0.10 PPM
TIME

Figure 3

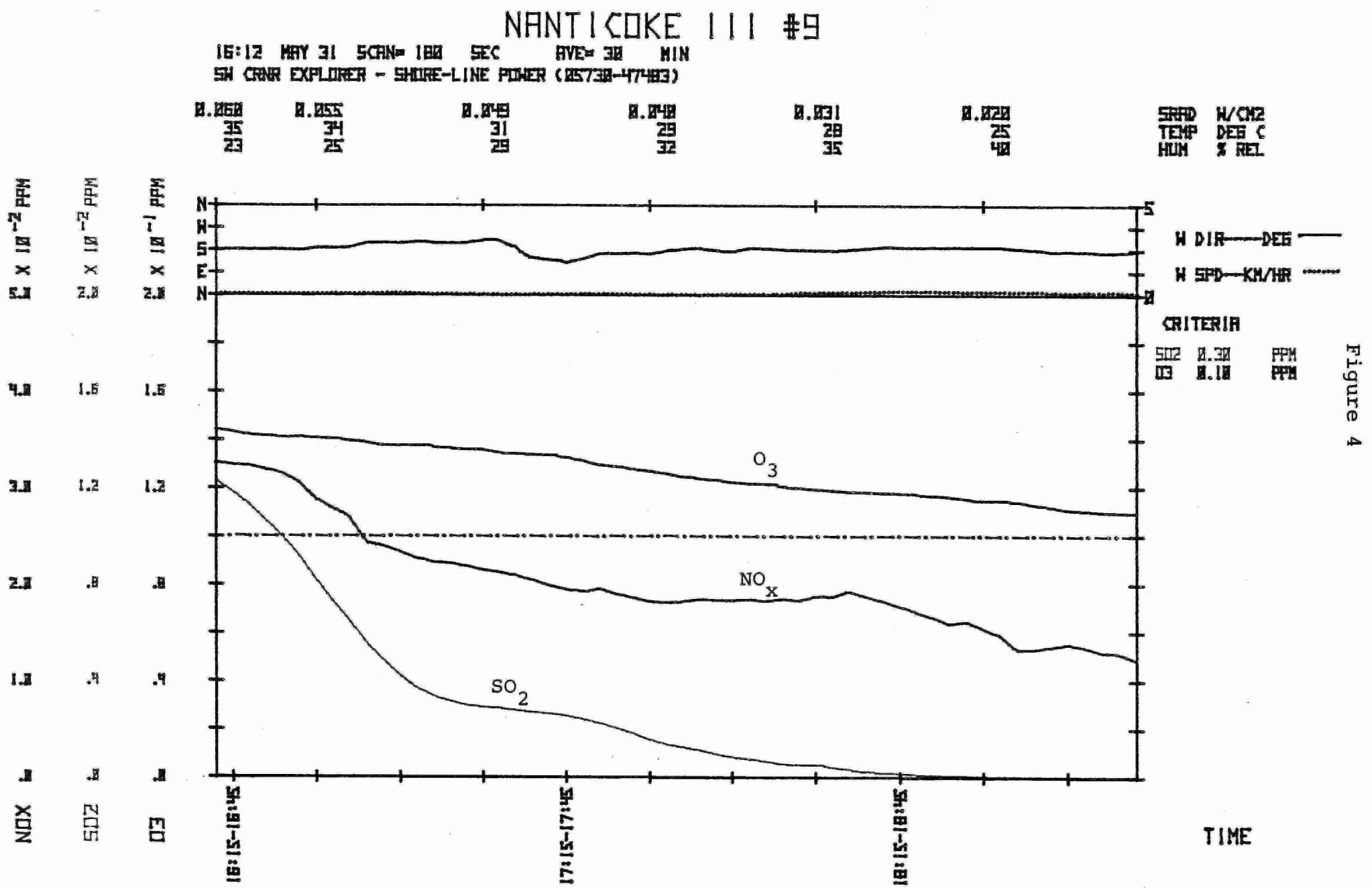
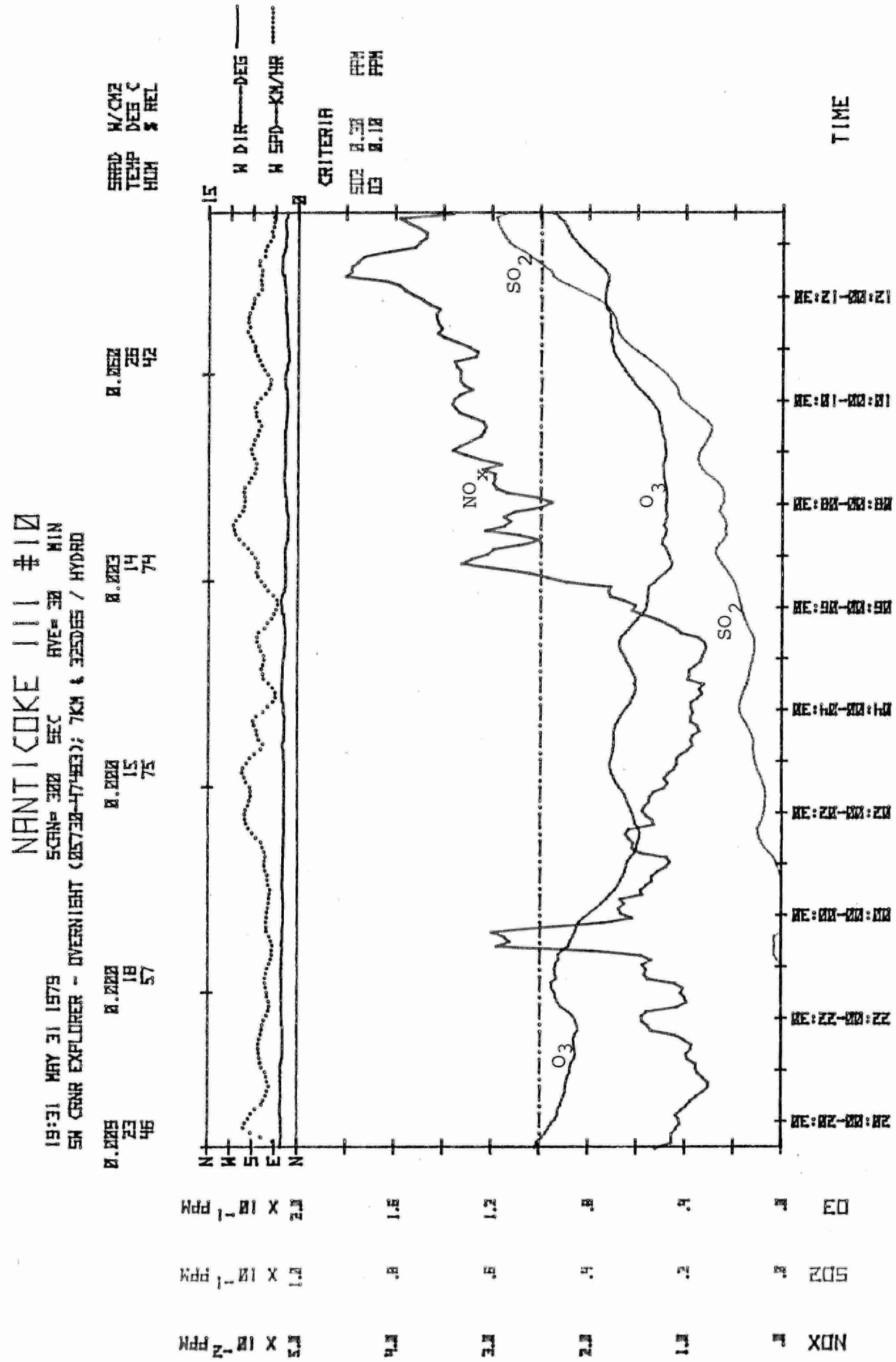
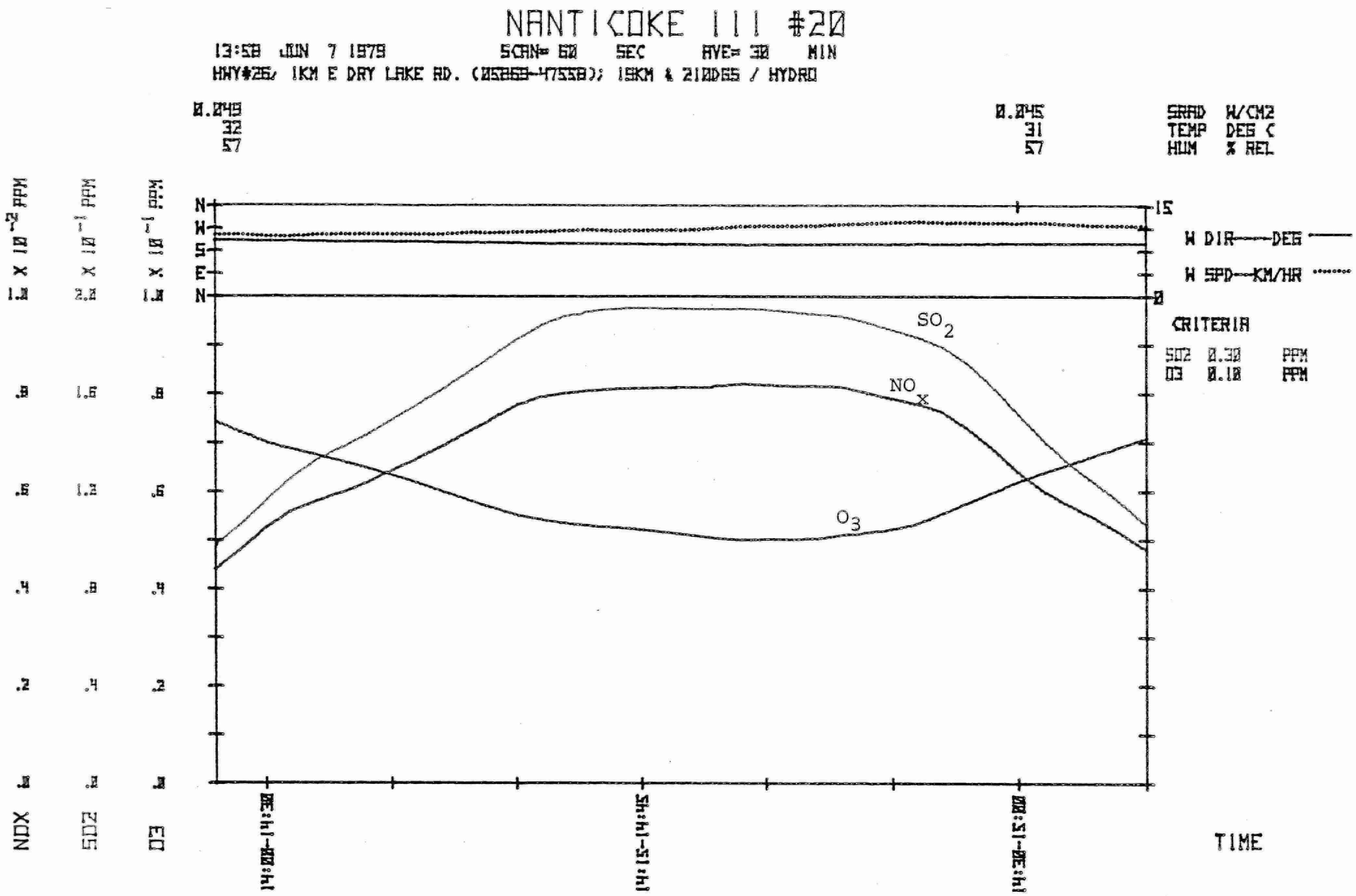

NANTICOKE III #9
16:12 MAY 31 SCAN= 180 SEC AVE= 30 MIN
SW CANA EXPLORER - SHORE-LINE POWER (85738-47483)
0.060 0.055 0.049 0.040 0.031 0.020
35 34 31 29 28 25
23 25 29 32 35 40
SRAD W/CM2
TEMP DEG C
HUM % REL
W DIR----DEG
W SPD---KM/HR
CRITERIA
SO2 0.30 PPM
O3 0.10 PPM
O3
NOX
SO2
TIME
16:15-16:45
17:15-17:45
18:15-18:45

Figure 4

Figure 5


NANTICOKE III #10
19:31 MAY 31 1979
SCAN= 300 SEC AVE= 30 MIN
SW CRNR EXPLORER - OVERNIGHT (0573B-47483); 7KM & 325DEG / HYDRO
SRAD W/CM2
TEMP DEG C
HUM % REL
W DIR——DEG
W SPD—KM/HR
CRITERIA
SO2 0.030 PPM
CO 0.010 PPM
TIME
NOX
SO2
O3
X 10⁻² PPM
X 10⁻¹ PPM



NANTICOKE III #20
13:58 JUN 7 1979 SCAN= 60 SEC AVE= 30 MIN
HWY#26, 1KM E DRY LAKE RD. (05869-47558); 15KM & 210DGS / HYDRO
0.049 32 57
0.045 31 57
SRAD W/CM2
TEMP DEG C
HUM % REL
W DIR——DEG
W SPD—KM/HR
CRITERIA
SO2 0.30 PPM
O3 0.10 PPM
SO2
NOx
O3
NOX
SO2
O3
TIME
14:00-14:30
14:15-14:45
14:30-15:00

Figure 6

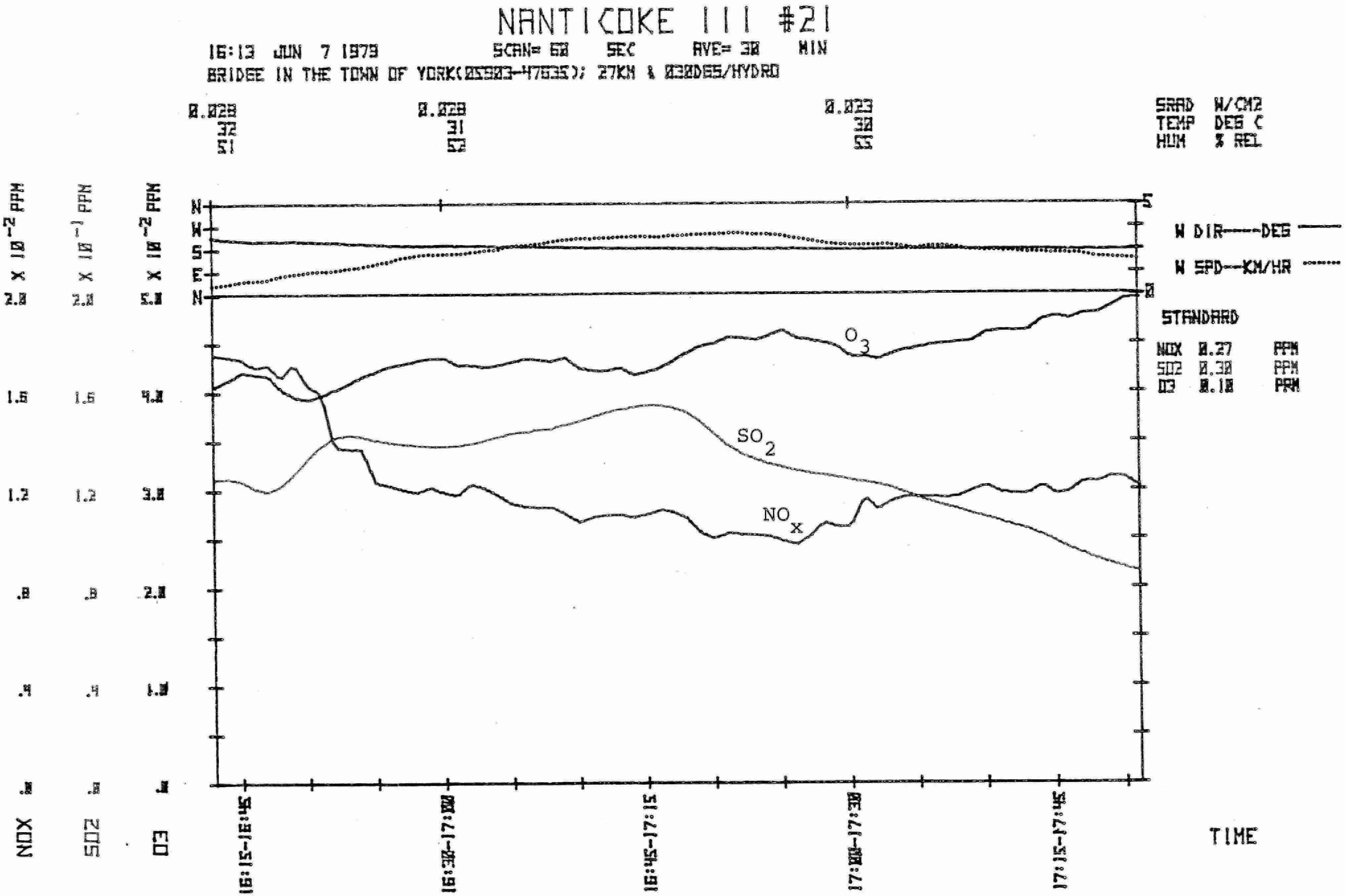

NANTICOKE III #21
16:13 JUN 7 1979
SCAN= 60 SEC
AVE= 30 MIN
BRIDEE IN THE TOWN OF YORK(05903-47635); 27KM & 030DEG/HYDRO
0.028
32
51
0.028
31
52
0.023
30
55
SRAD W/CM2
TEMP DEG C
HUM % REL
W DIR----DEG
W SPD---KM/HR
STANDARD
NOX 0.27 PPM
SO2 0.30 PPM
O3 0.10 PPM
N
W
S
E
N
5
0
O_3
SO_2
NO_x
X 10^-2 PPM
X 10^-1 PPM
X 10^-2 PPM
2.0
1.6
1.2
.8
.4
.0
2.0
1.6
1.2
.8
.4
.0
5.0
4.0
3.0
2.0
1.0
.0
NOX
SO2
O3
16:15-16:45
16:30-17:00
16:45-17:15
17:00-17:30
17:15-17:45
TIME

Figure 7

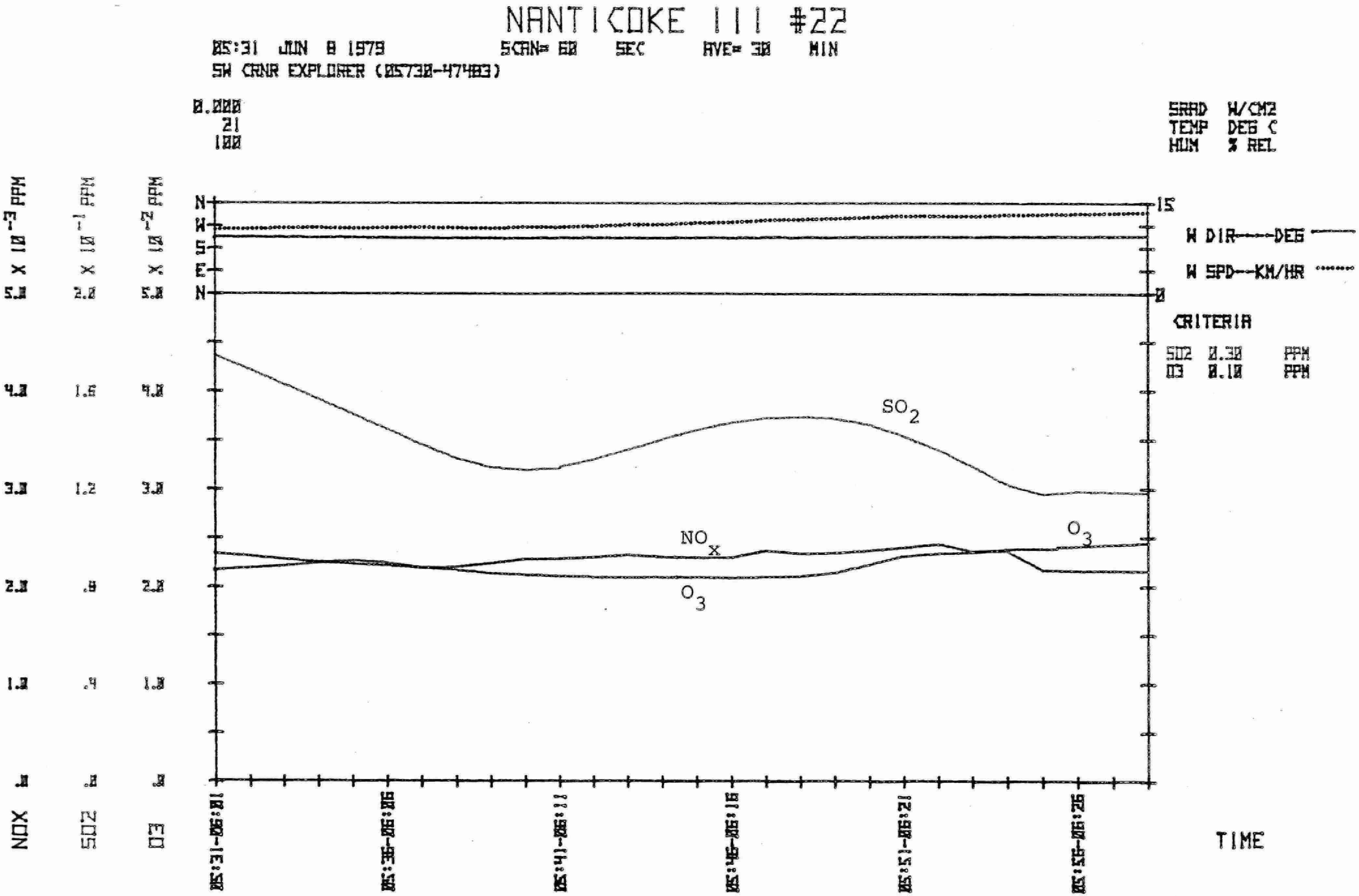

NANTICOKE III #22
05:31 JUN 8 1979 SCAN= 60 SEC AVE= 30 MIN
SW CRNR EXPLORER (05730-47483)
0.000
21
100
SRAD W/CM2
TEMP DEG C
HUM % REL
W DIR----DEG
W SPD--KM/HR
CRITERIA
SO2 0.30 PPM
O3 0.10 PPM
SO2
NOx
O3
NOX
SO2
O3
TIME

Figure 8

Figure 9

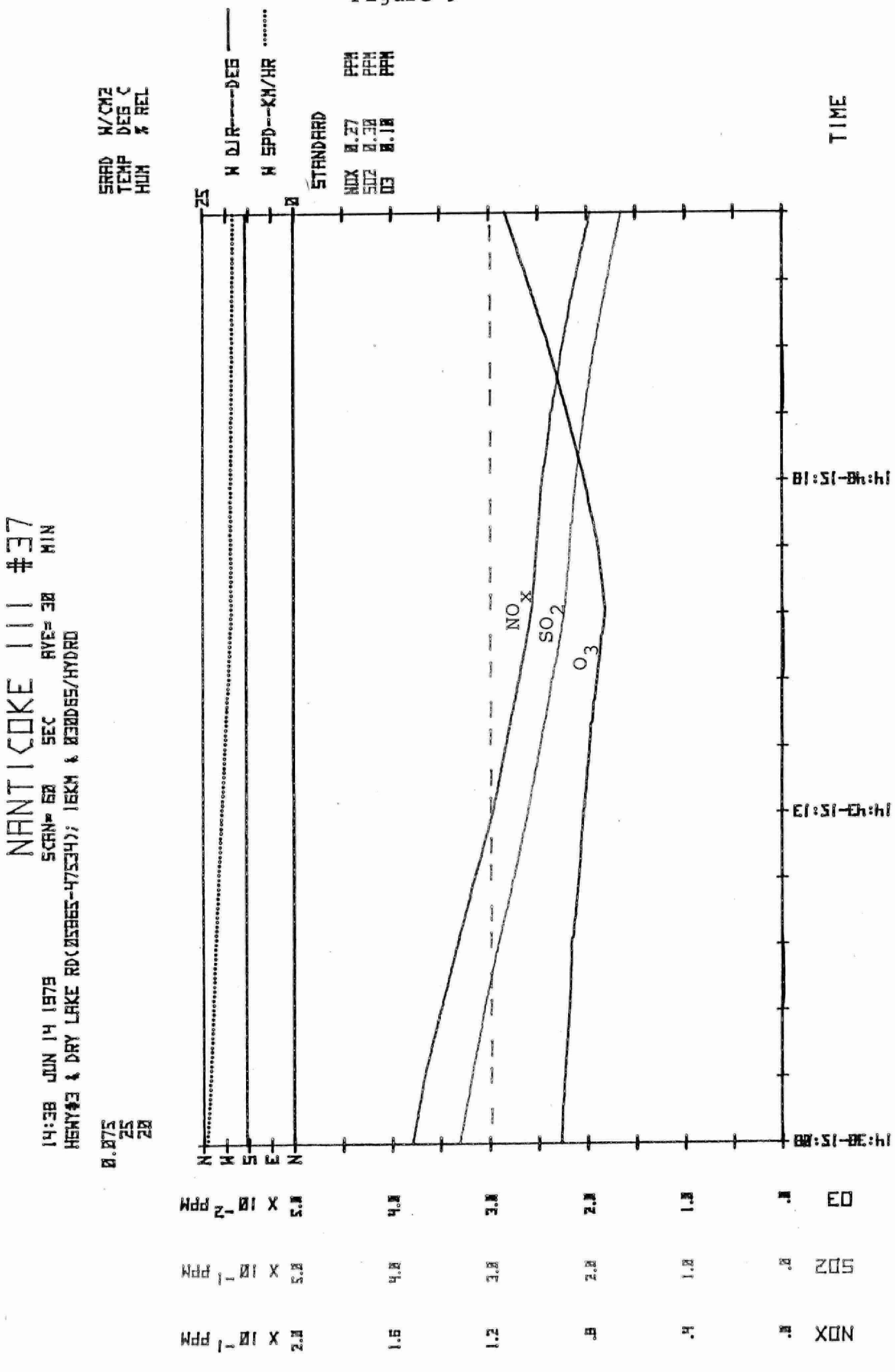
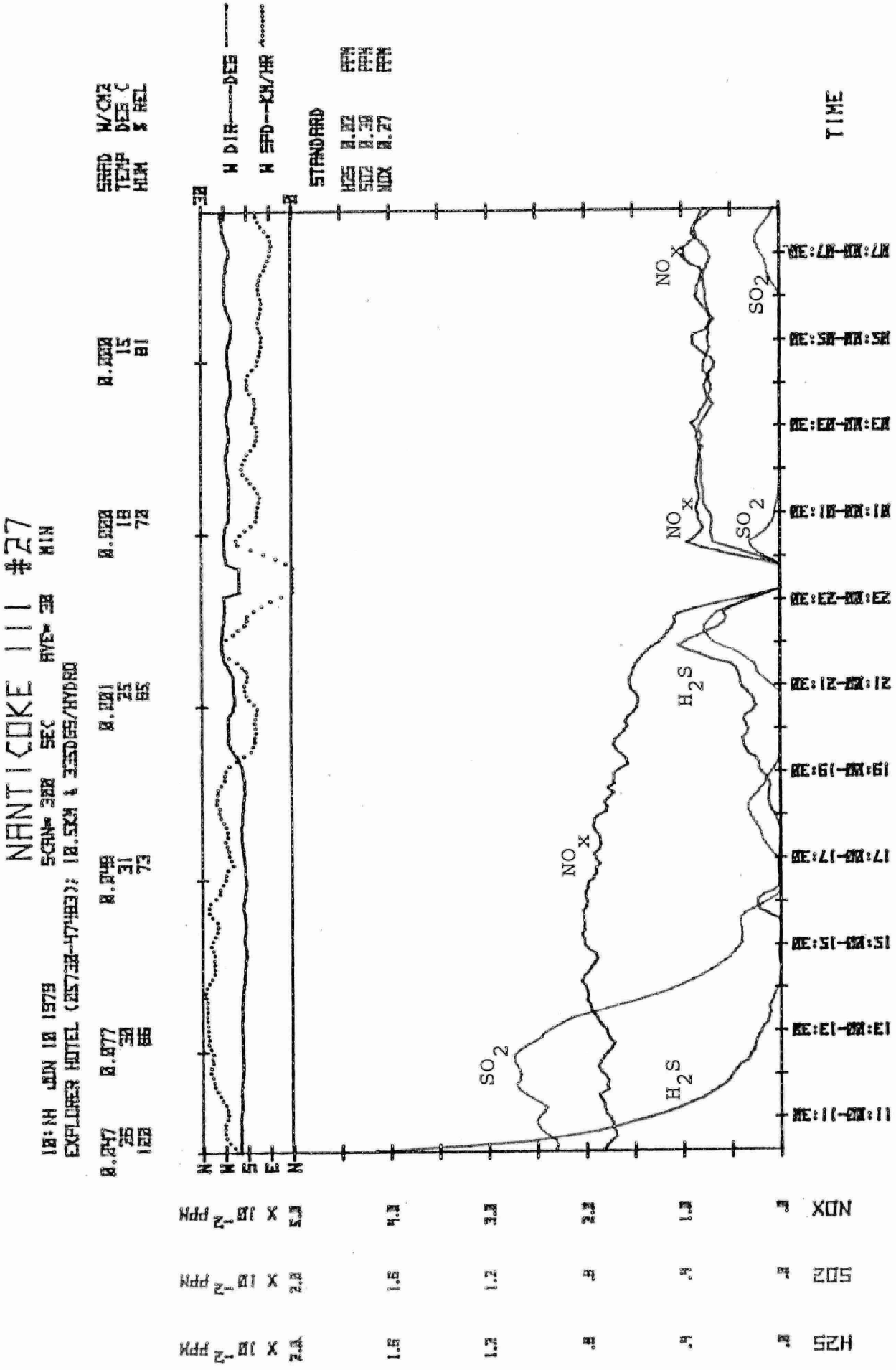
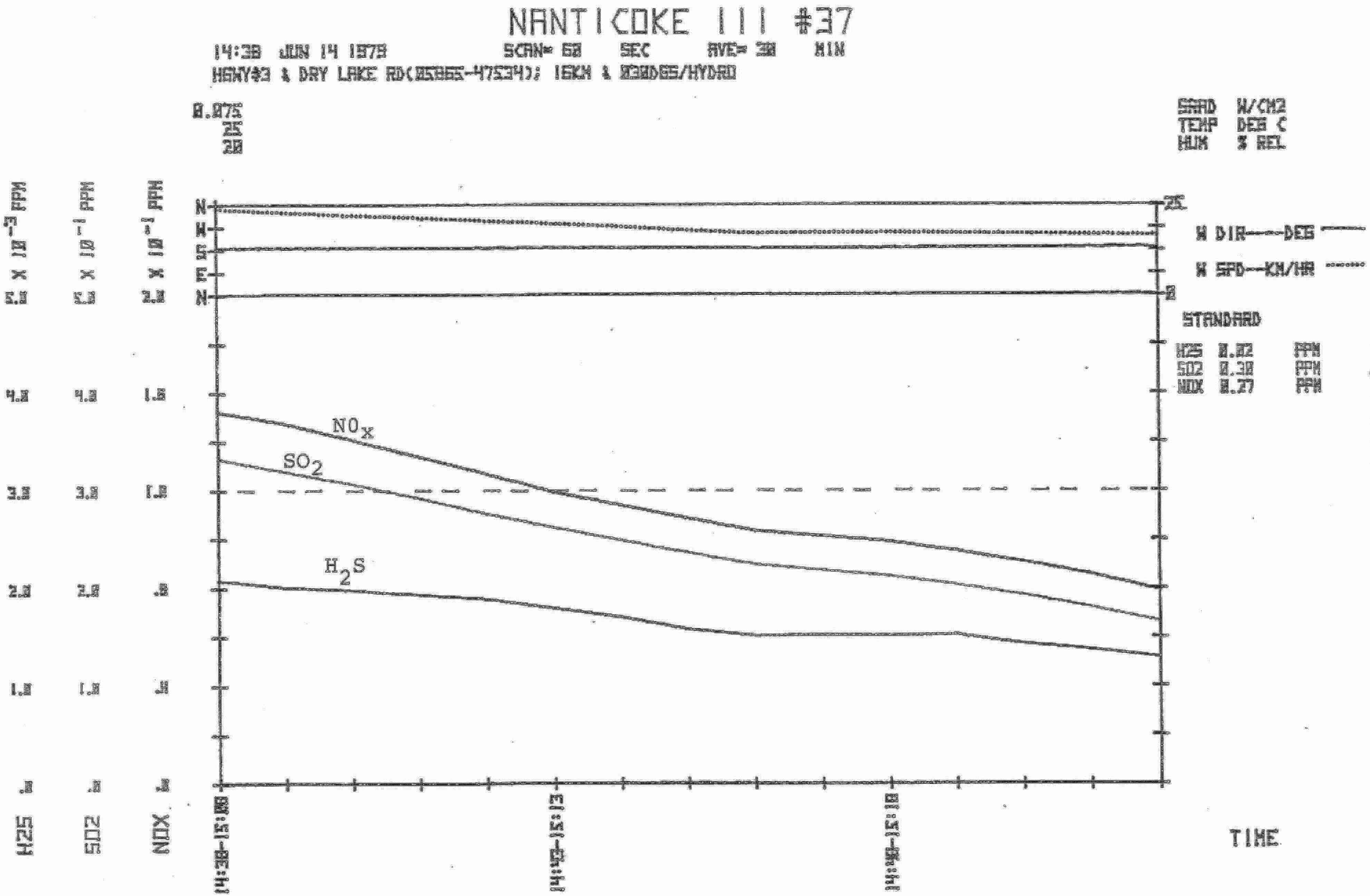

NANTICOKE III #37
14:38 JUN 14 1979
SCAN= 60 SEC AVE= 30 MIN
HWY#3 & DRY LAKE RD(0386S-47534); 16KM & 030DEG/HYDRO
SRAD W/CM2
TEMP DEG C
HUM % REL
0.075
25
20
W DIR----DEG
W SPD--KM/HR
STANDARD
NOX 0.27 PPM
SO2 0.30 PPM
O3 0.10 PPM
25
0
N
NW
W
SW
S
SE
E
NE
N
NO$_x$
SO$_2$
O$_3$
TIME
18:30-15:18
13:30-15:13
08:30-15:08
NOX
SO2
O3
PPM
X 10^{-1} PPM
X 10^{-2} PPM

Figure 10

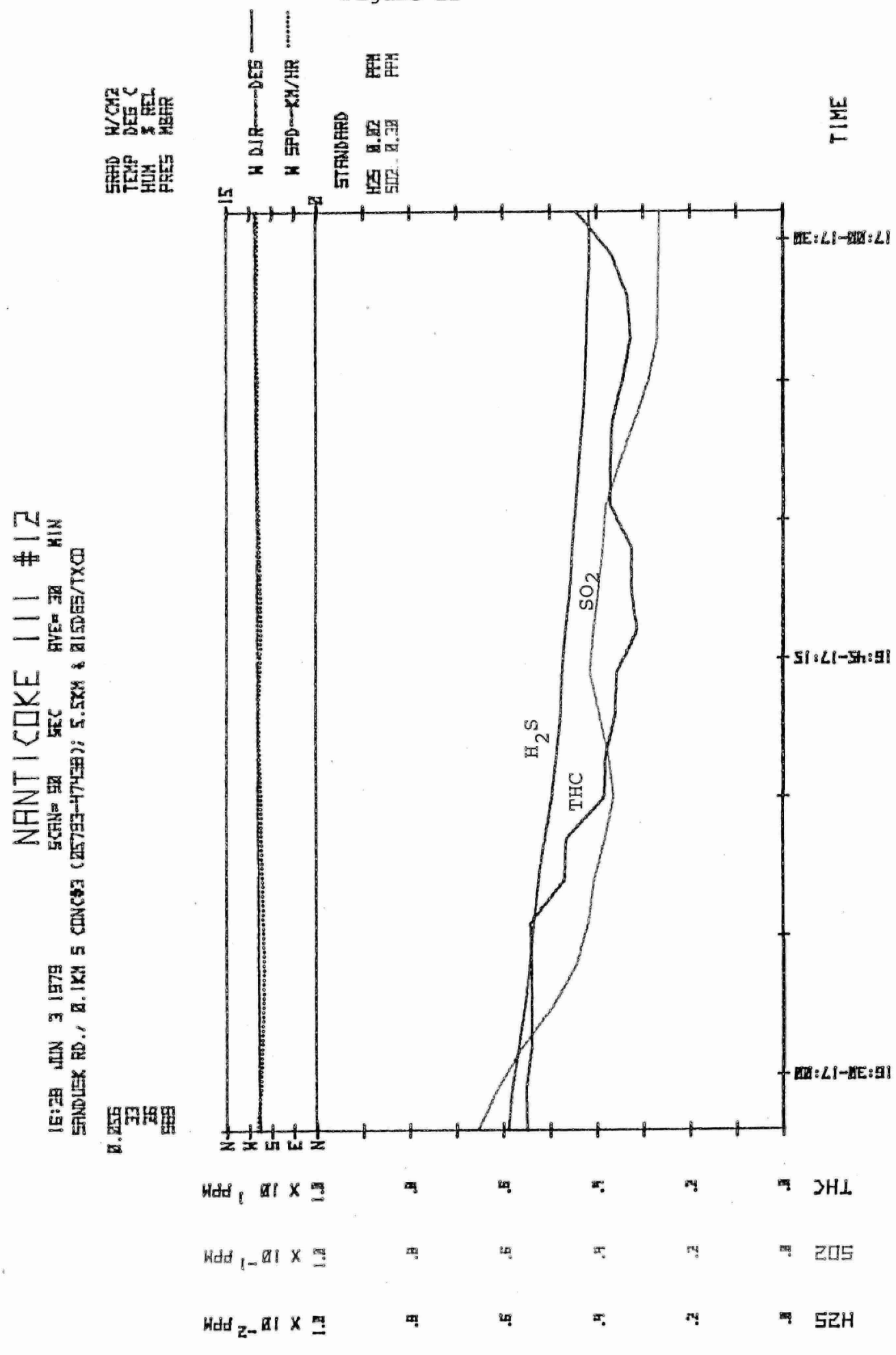

NANTICOKE III #27
10:NN JUN 10 1979
EXPLORER HOTEL (25738-47483); 10.5KM & 335DEG/HYDRO
SCAN= 300 SEC AVE= 30 MIN
SRAD W/CM2
TEMP DEG C
HUM % REL
H DIR——DEG
H SPD--KM/HR
STANDARD
H2S
SO2
NOX
TIME
NOX
SO2
H2S
NOX
SO2
H2S
NOX
SO2



NANTICOKE III #37
14:30 JUN 14 1979 SCAN= 60 SEC AVE= 30 MIN
HGWY#3 & DRY LAKE RD(05865-47534); 16KM & 030DEG/HYDRO
0.075
25
20
SRAD W/CM2
TEMP DEG C
HUM % REL
5.0 X 10^-3 PPM
5.0 X 10^-1 PPM
2.0 X 10^-1 PPM
W DIR----DEG
W SPD--KM/HR
STANDARD
H2S 0.02 PPM
SO2 0.30 PPM
NOX 0.27 PPM
NOx
SO2
H2S
H2S
SO2
NOX
14:30-15:00
14:40-15:13
14:50-15:10
TIME

Figure 11

Figure 12


NANTICOKE III #12
SCAN= 930 SEC AVE= 30 MIN
SANDUSK RD., 0.1KM S CONC@3 (285793-4743EB); 5.5KM @ 015DEG/TXCO
W DIR----DEG
W SPD--KM/HR
STANDARD
H2S 0.002 PPM
SO2 0.38 PPM
SRAD W/CM2
TEMP DEG C
HUM % REL
PRES MBAR
TIME
H2S
SO2
THC
PPM
PPM
PPM

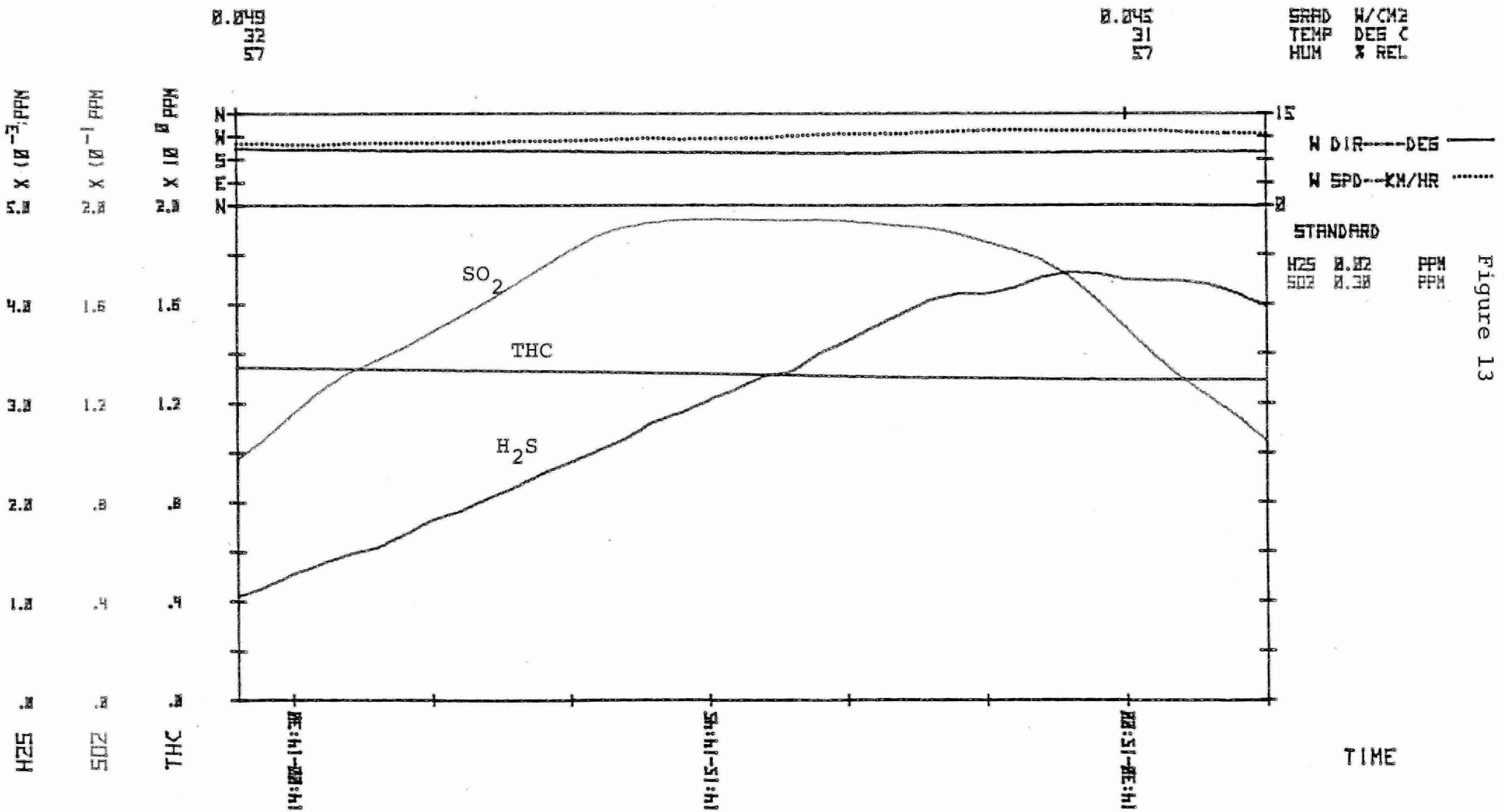

NANTICOKE III #20
13:58 JUN 7 1979
SCAN= 60 SEC
AVE= 30 MIN
HWY#25, 1KM E DRY LAKE RD. (05863-47558); 19KM & 030D65/HYDRO
0.049
32
57
0.045
31
57
SRAD W/CM2
TEMP DEG C
HUM % REL
W DIR-----DEG
W SPD--KM/HR
STANDARD
H2S 0.02 PPM
SO2 0.38 PPM
SO2
THC
H2S
TIME
H2S
SO2
THC

Figure 13

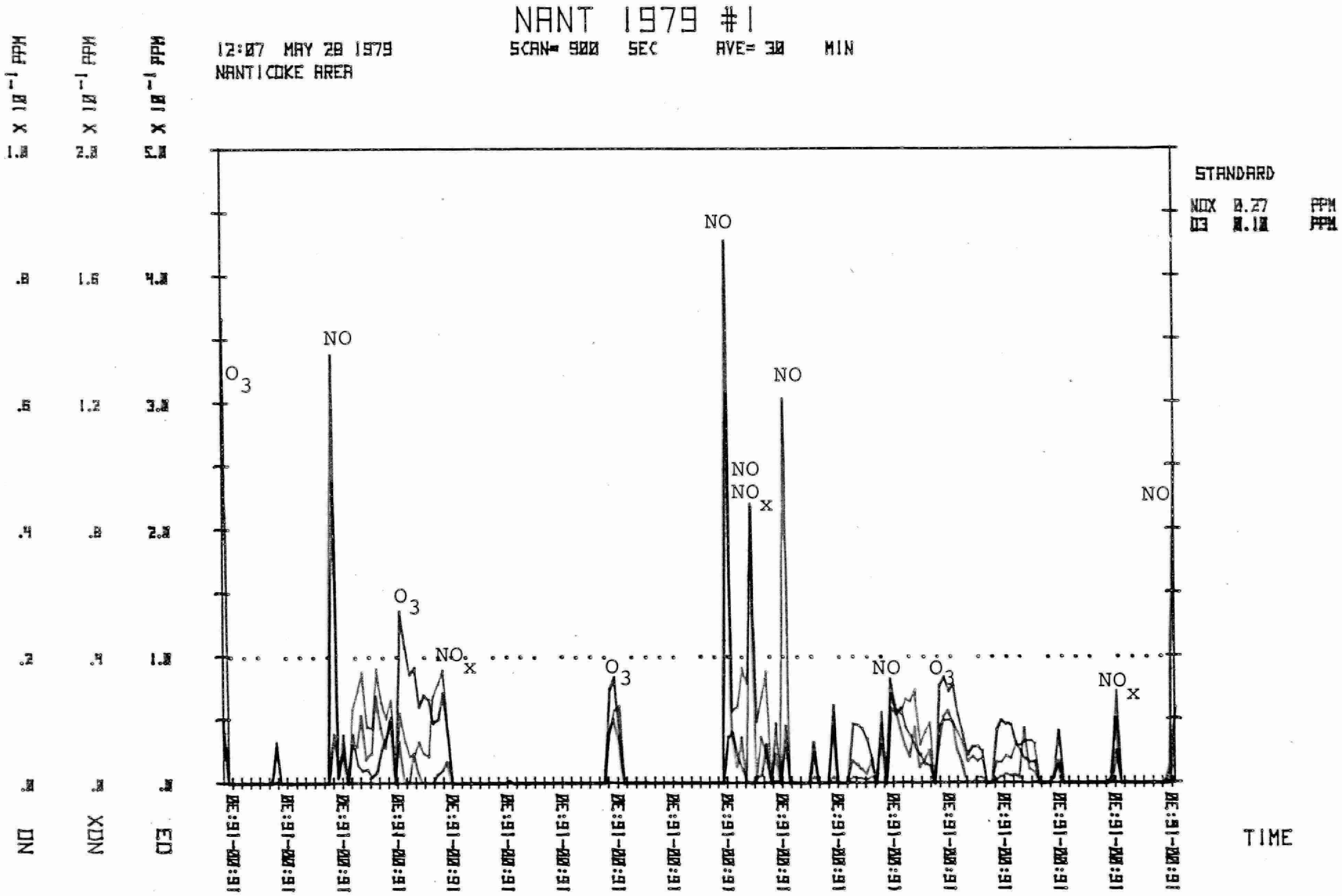
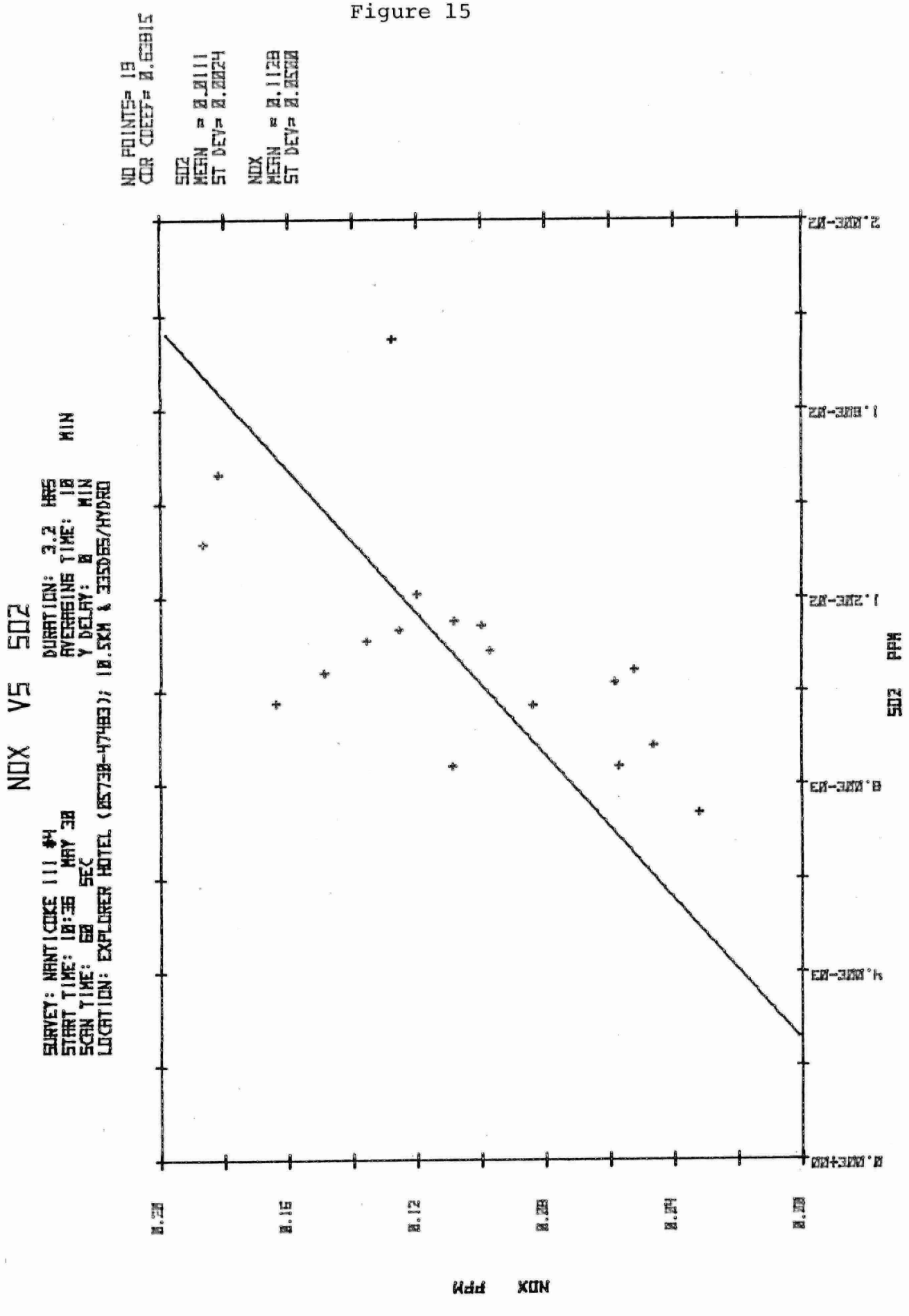

NANT 1979 #1
12:07 MAY 28 1979
NANTICOKE AREA
SCAN= 900 SEC
AVE= 30 MIN
STANDARD
NOX 0.27 PPM
O3 0.10 PPM
NO
NOX
O3
TIME

Figure 14

Figure 15


NOX V5 SO2
SURVEY: MANTICORE III #4
START TIME: 10:35 MAY 30
SCAN TIME: 60 SEC
LOCATION: EXPLORER HOTEL (85738-47483); 10.5KM & 335DEG/HYDRO
DURATION: 3.2 HRS
AVERAGING TIME: 10 MIN
Y DELAY: 0 MIN
NO POINTS= 19
COR COEFF= 0.63815
SO2
MEAN = 0.0111
ST DEV= 0.0024
NOX
MEAN = 0.1128
ST DEV= 0.0538
NOX PPM
SO2 PPM

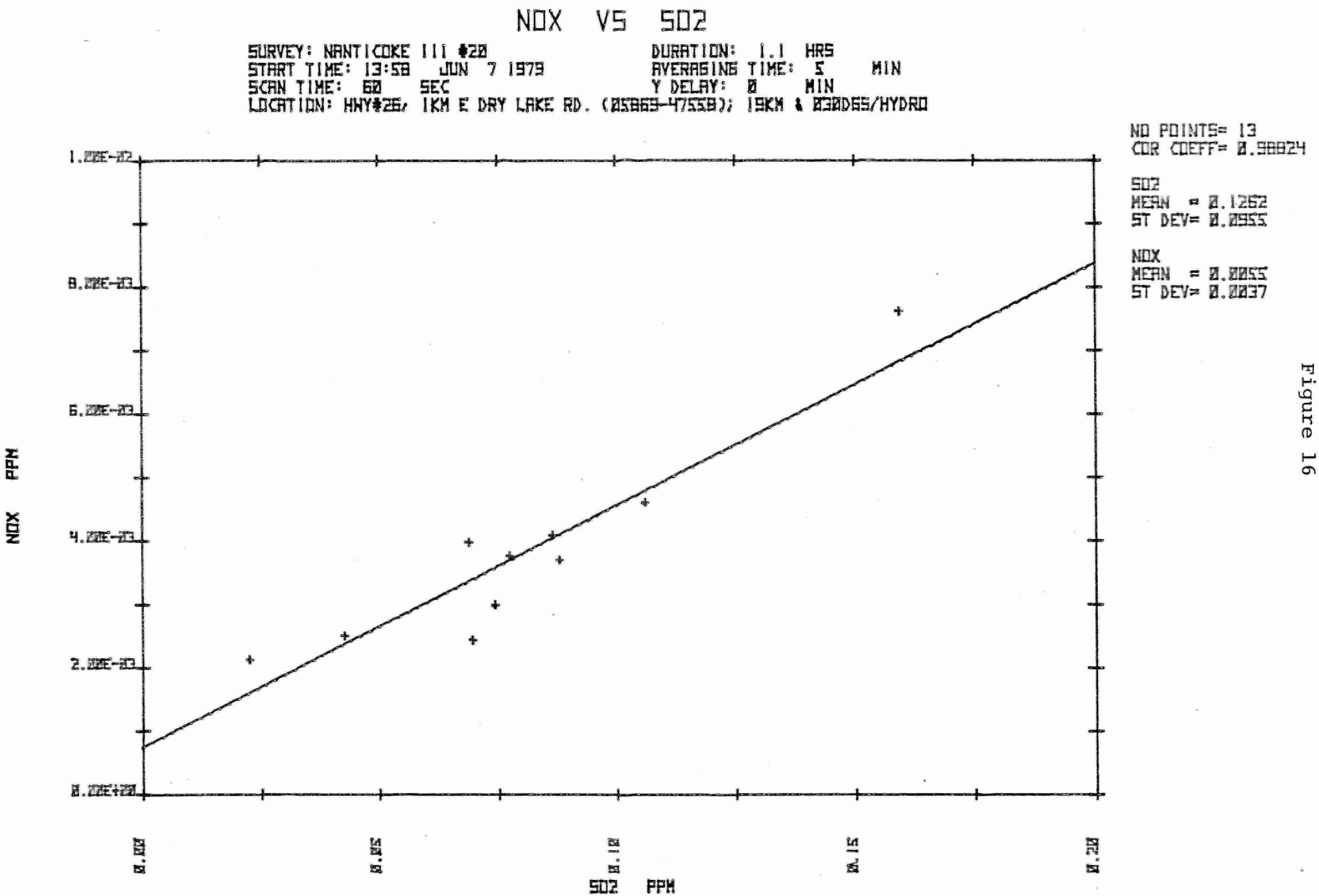

NOX VS SO2
SURVEY: NANTICOKE III #20
START TIME: 13:58 JUN 7 1979
SCAN TIME: 60 SEC
LOCATION: HWY#26, 1KM E DRY LAKE RD. (05863-47558); 19KM & 030D65/HYDRO
DURATION: 1.1 HRS
AVERAGING TIME: 5 MIN
Y DELAY: 0 MIN
NO POINTS= 13
COR COEFF= 0.98824
SO2
MEAN = 0.1262
ST DEV= 0.0955
NOX
MEAN = 0.0055
ST DEV= 0.0037
NOX PPM
SO2 PPM

Figure 16

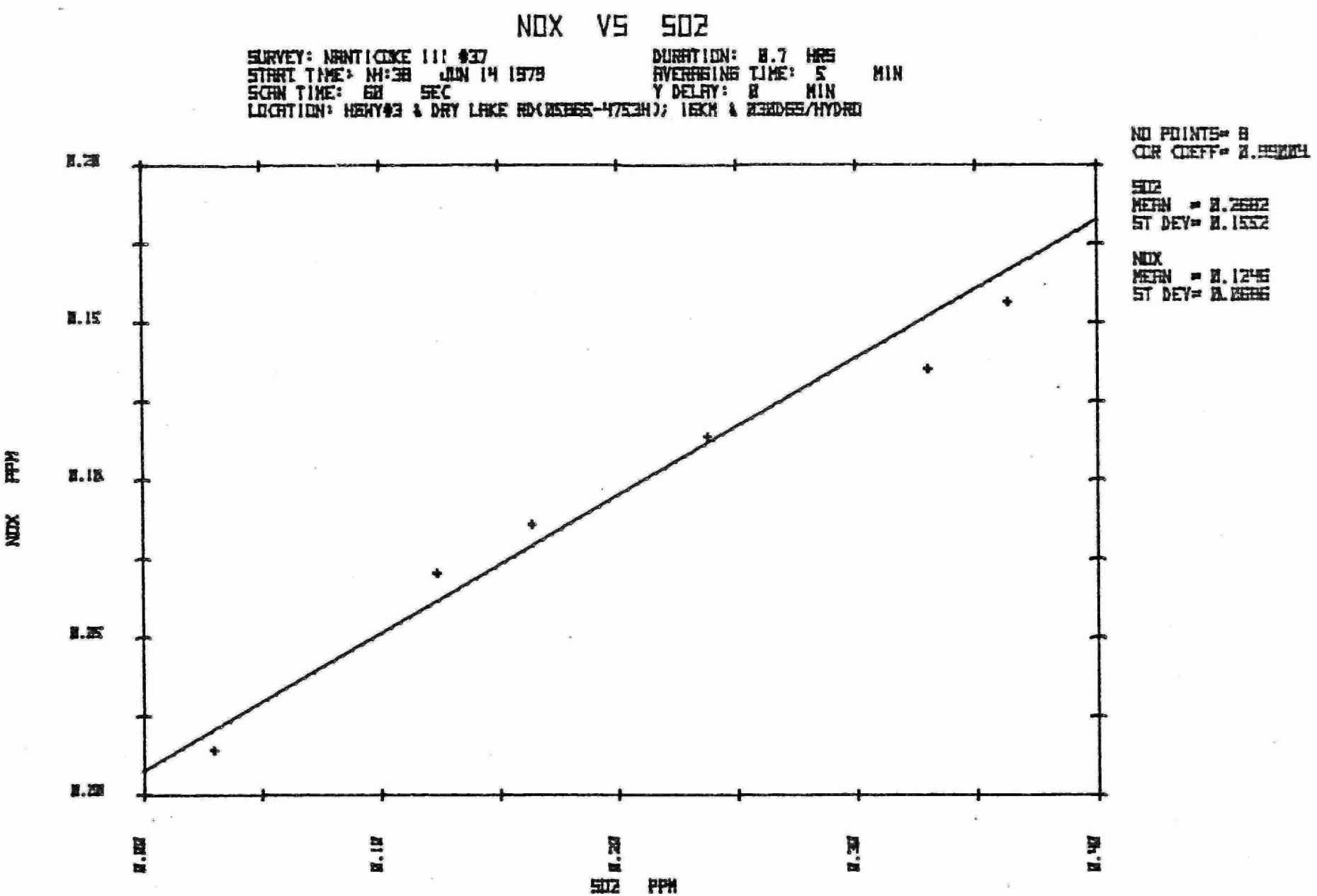

NOX VS SO2
SURVEY: MANTICORE III #37
START TIME: HH:MM JUN 14 1979
SCAN TIME: 60 SEC
LOCATION: HWY#3 & DRY LAKE RD(XXXXX-YYYYH); 16KM & XXXXX/HYDRO
DURATION: 0.7 HRS
AVERAGING TIME: 5 MIN
Y DELAY: 0 MIN
NO POINTS= 8
COR COEFF= 0.XXXXX
SO2
MEAN = 0.2682
ST DEV= 0.1552
NOX
MEAN = 0.1245
ST DEV= 0.0886
NOX PPM
SO2 PPM

Figure 17

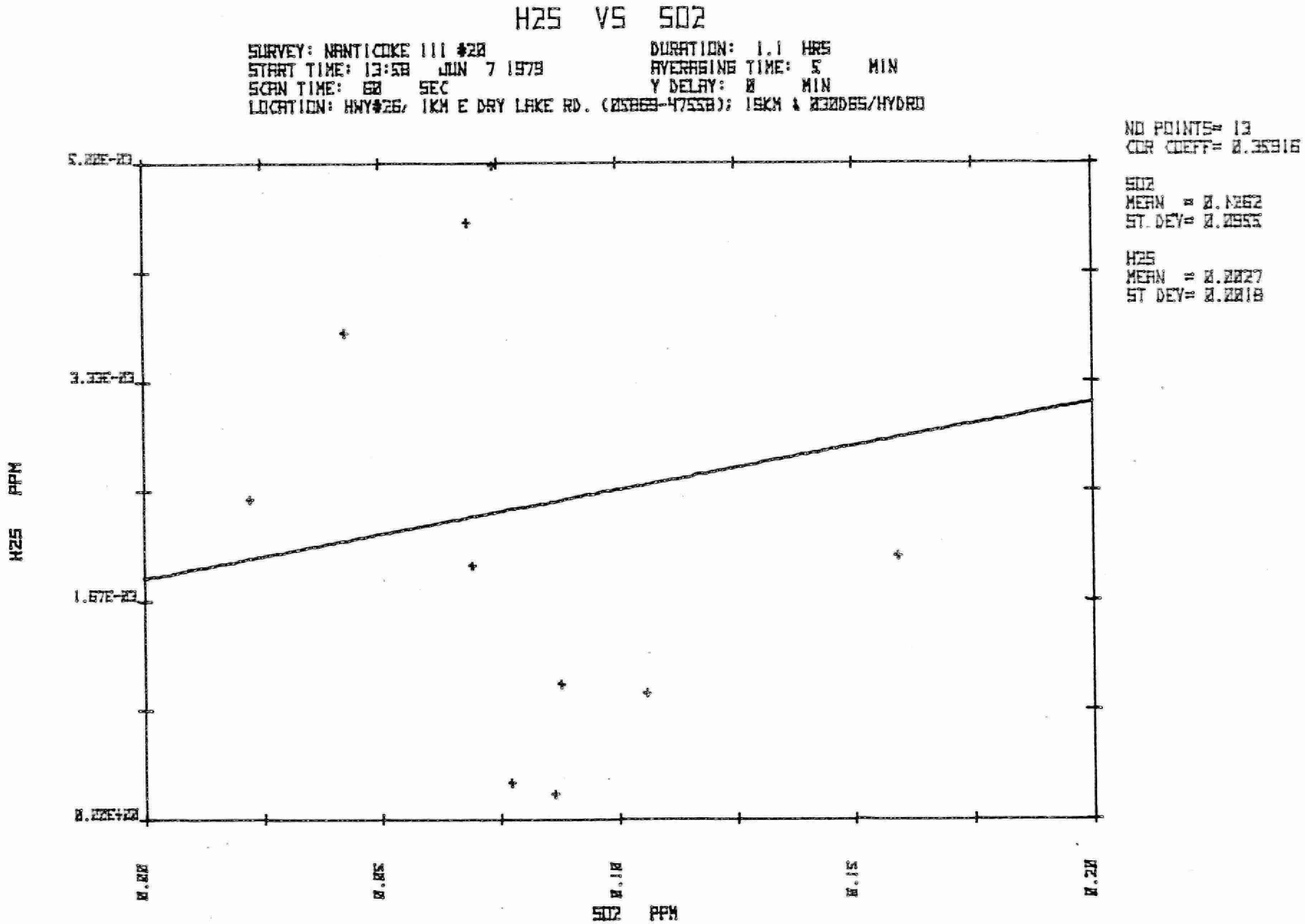
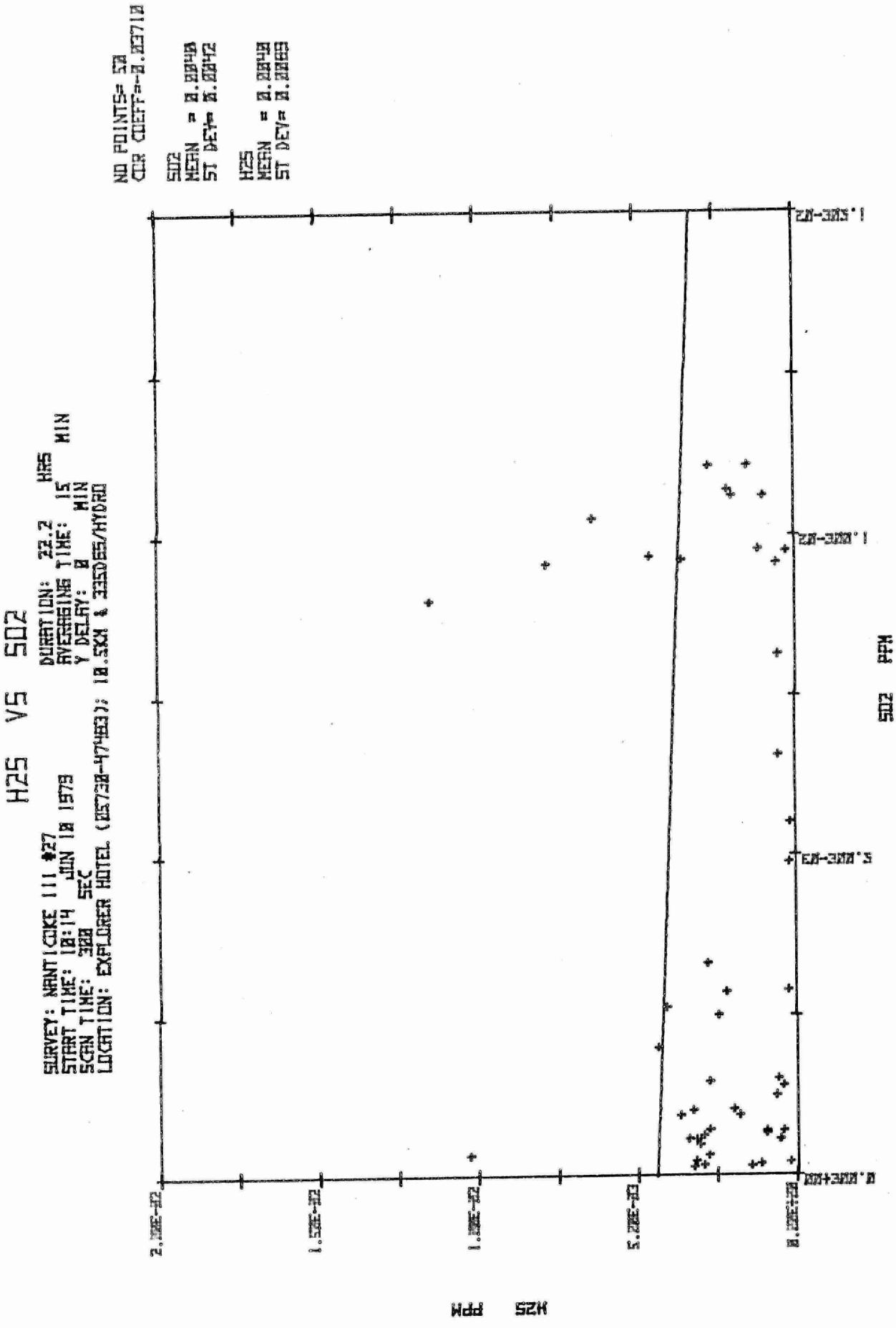

H2S VS SO2
SURVEY: NANTICOKE III #20
START TIME: 13:58 JUN 7 1979
SCAN TIME: 60 SEC
LOCATION: HWY#26, 1KM E DRY LAKE RD. (05868-47558); 15KM & 030DEG/HYDRO
DURATION: 1.1 HRS
AVERAGING TIME: 5 MIN
Y DELAY: 0 MIN
NO POINTS= 13
COR COEFF= 0.35916
SO2
MEAN = 0.1262
ST. DEV= 0.0555
H2S
MEAN = 0.0027
ST DEV= 0.0018
5.00E-03
3.33E-03
1.67E-03
0.00E+00
H2S PPM
0.00
0.05
0.10
0.15
0.20
SO2 PPM

Figure 18

Figure 19


H2S VS SO2
SURVEY: WANT/COKE III #27
START TIME: 10:14 JUN 18 1978
SCAN TIME: 300 SEC
LOCATION: EXPLORER HOTEL (05738-47463): 10.5KM @ 335DEG/HYDRO
DURATION: 22.2 HRS
AVERAGING TIME: 15 MIN
Y DELAY: 0 MIN
NO POINTS= 53
COR COEFF=-0.03710
SO2
MEAN = 0.00043
ST DEV= 0.00042
H2S
MEAN = 0.00043
ST DEV= 0.00083
SO2 PPM
H2S PPM

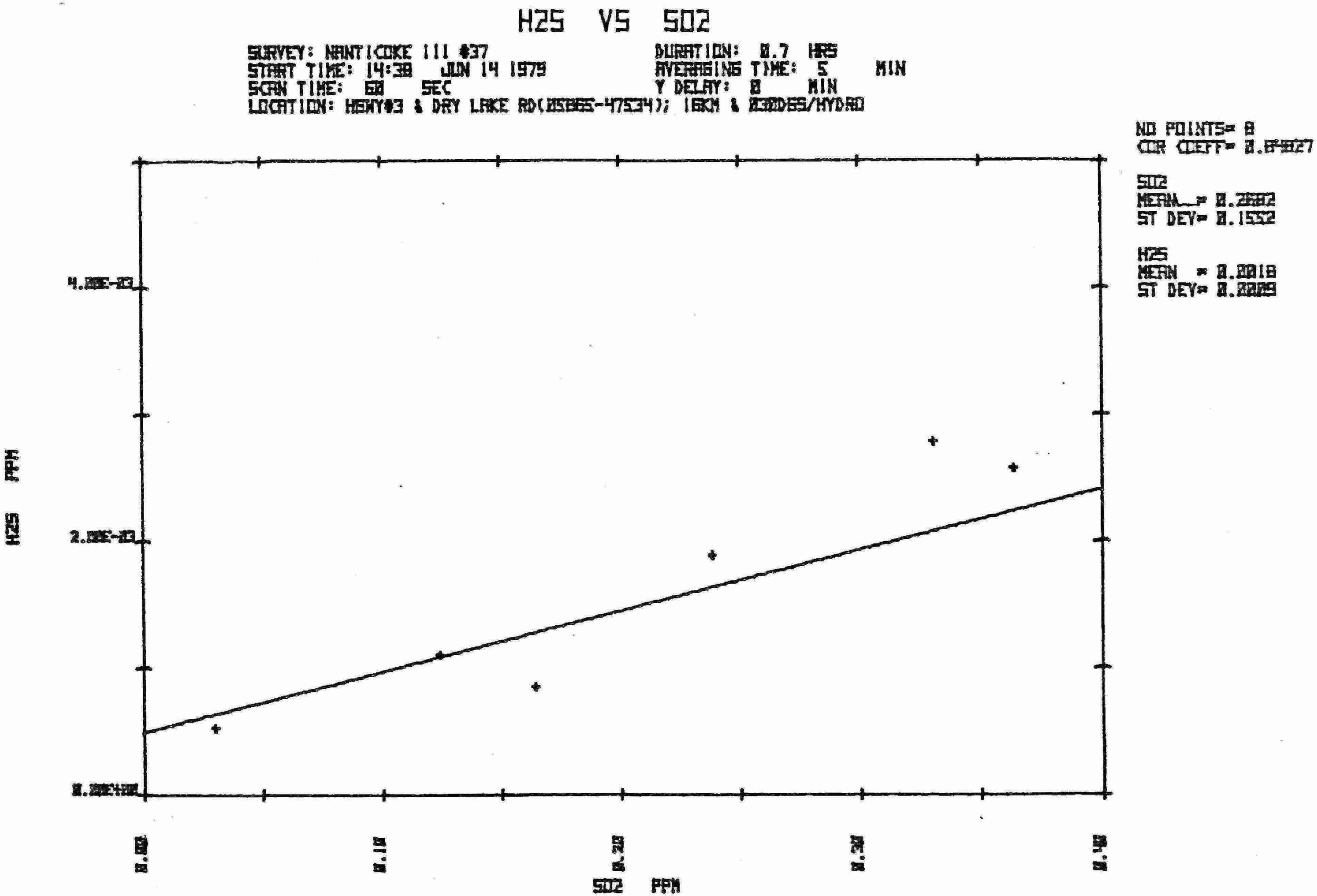

H2S VS SO2
SURVEY: NANTICOKE III #37
START TIME: 14:30 JUN 14 1979
SCAN TIME: 60 SEC
LOCATION: HGWY#3 & DRY LAKE RD(05865-47534); 16KM & 030DEG/HYDRO
DURATION: 0.7 HRS
AVERAGING TIME: 5 MIN
Y DELAY: 0 MIN
NO POINTS= 8
COR COEFF=
SO2
MEAN = 0.2682
ST DEV= 0.1552
H2S
MEAN = 0.0018
ST DEV= 0.0009
4.00E-03
2.00E-03
0.00E+00
H2S PPM
0.00
0.10
0.20
0.30
0.40
SO2 PPM

Figure 20

Figure 21

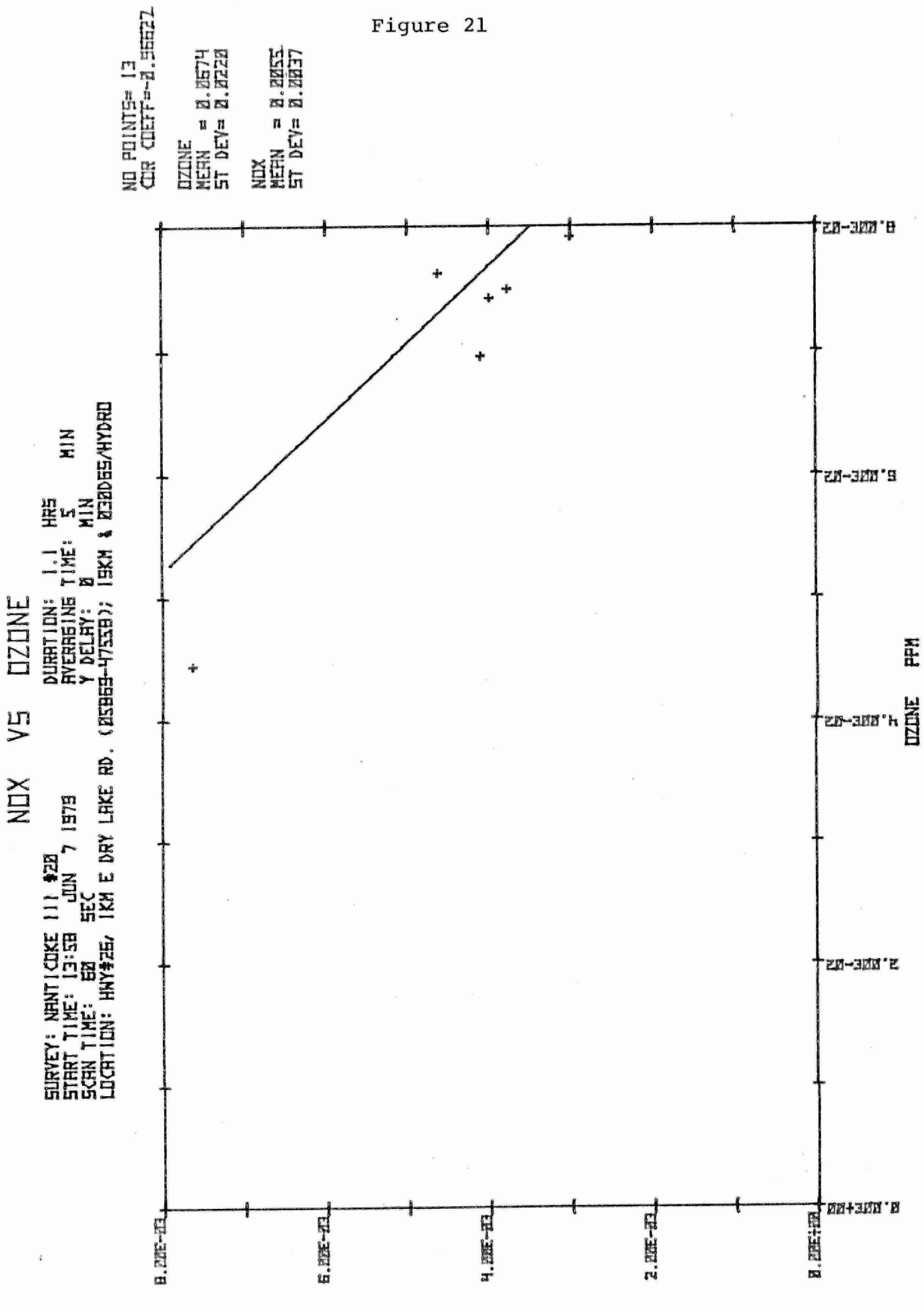
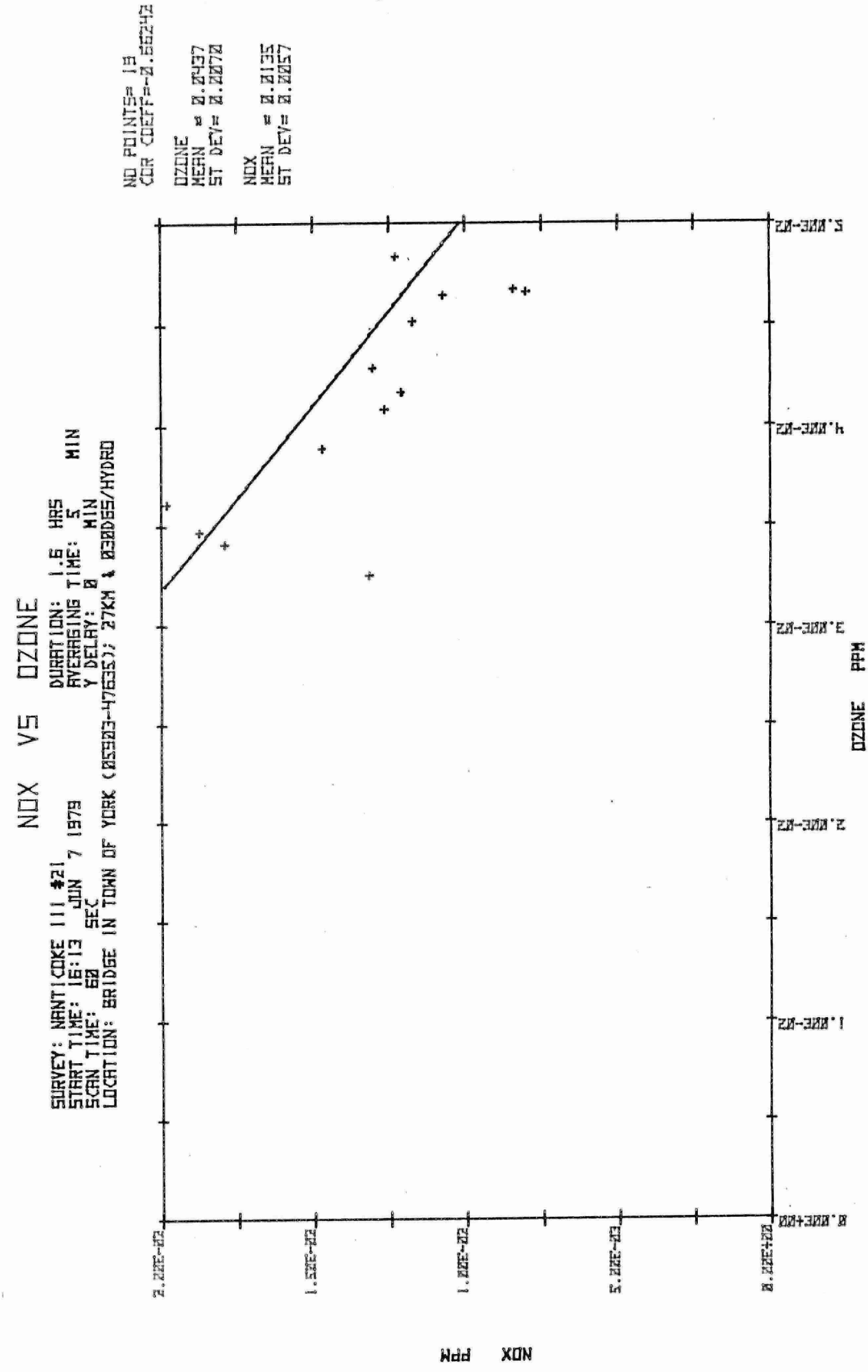

NO POINTS= 13
COR COEFF=-0.56627
OZONE
MEAN = 0.0574
ST DEV= 0.0220
NOX
MEAN = 0.0055
ST DEV= 0.0037
NOX V5 OZONE
SURVEY: NANTICOKE III #20
START TIME: 13:58 JUN 7 1979
SCAN TIME: 60 SEC
LOCATION: HWY#25, 1KM E DRY LAKE RD. (05869-47558); 19KM & 030DEG/HYDRO
DURATION: 1.1 HRS
AVERAGING TIME: 5 MIN
Y DELAY: 0 MIN
8.00E-02
6.00E-02
4.00E-02
2.00E-02
0.00E+00
8.00E-03
6.00E-03
4.00E-03
2.00E-03
0.00E+00
OZONE PPM
NOX PPM

Figure 22


NOX VS OZONE
SURVEY: NANTICOKE III #21
START TIME: 16:13 JUN 7 1979
SCAN TIME: 60 SEC
LOCATION: BRIDGE IN TOWN OF YORK (05903-47635); 27KM & 030DEG/HYDRO
DURATION: 1.6 HRS
AVERAGING TIME: 5 MIN
Y DELAY: 0 MIN
NO POINTS= 13
COR COEFF=-0.662942
OZONE
MEAN = 0.2437
ST DEV= 0.0078
NOX
MEAN = 0.0135
ST DEV= 0.0057
OZONE PPM
NOX PPM

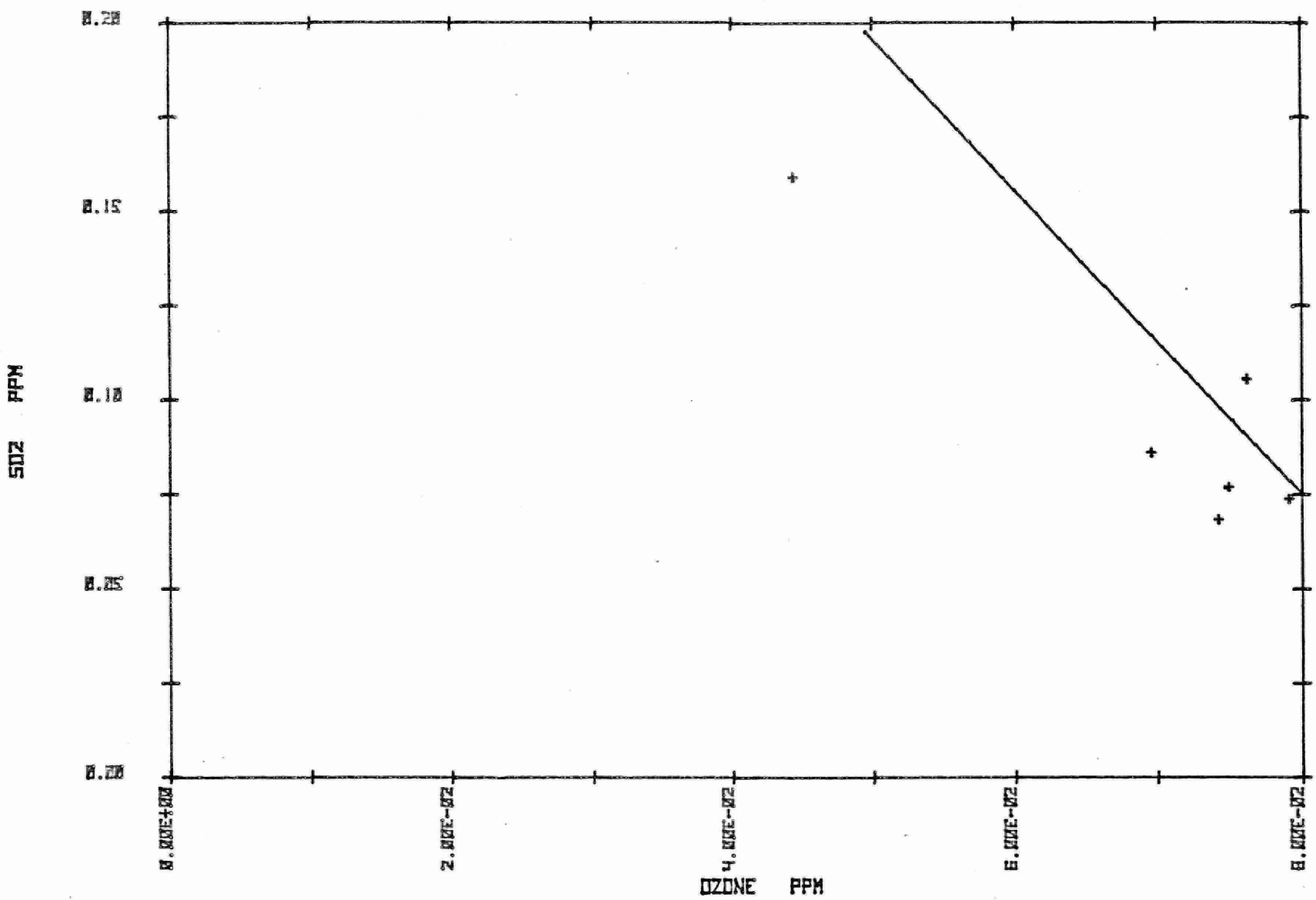

SO2 VS OZONE
SURVEY: NANTICOKE III #20
START TIME: 13:58 JUN 7 1979
SCAN TIME: 60 SEC
LOCATION: HWY#26, 1KM E DRY LAKE RD. (05863-47558); 19KM & 030DEG/HYDRO
DURATION: 1.1 HRS
AVERAGING TIME: 5 MIN
Y DELAY: 0 MIN
NO POINTS= 13
COR COEFF=-0.92602
OZONE
MEAN = 0.2674
ST DEV= 0.0228
SO2
MEAN = 0.1262
ST DEV= 0.0955
SO2 PPM
0.20
0.15
0.10
0.05
0.00
0.000E+00
2.000E-02
4.000E-02
6.000E-02
8.000E-02
OZONE PPM

Figure 23

THC VS OZONE

SURVEY: NANTICOKE III #20
START TIME: 13:58 JUN 7 1979
SCAN TIME: 60 SEC
LOCATION: HWY#26, 1KM E DRY LAKE RD. (05869-47558); 19KM & 030DEG/HYDRO

DURATION: 1.1 HRS
AVERAGING TIME: 5 MIN
Y DELAY: 0 MIN

NO POINTS= 13
COR COEFF= 0.19298

OZONE
MEAN = 0.0674
ST DEV= 0.0220

THC
MEAN = 1.3171
ST DEV= 0.0306

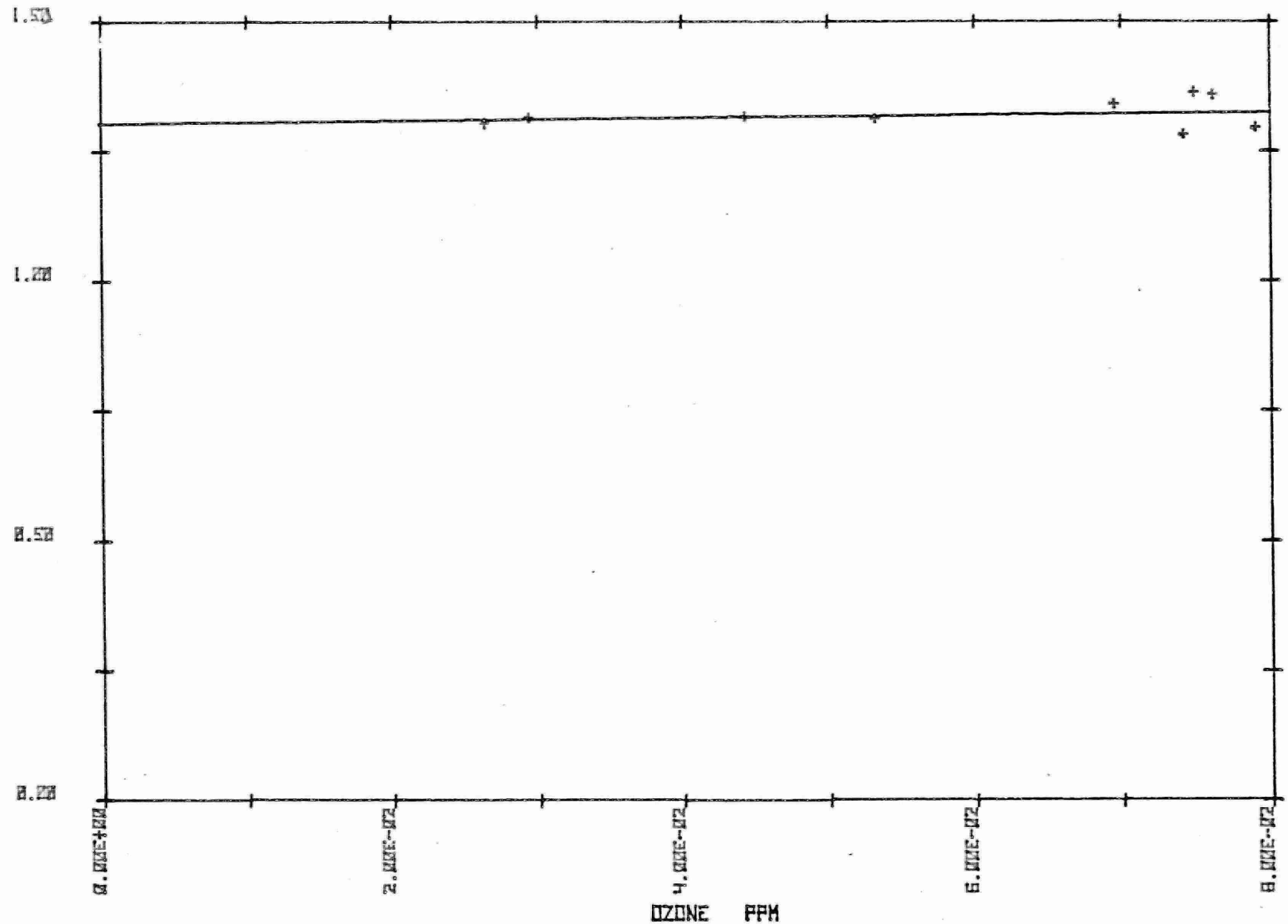


Figure 24

H2S VS OZONE

SURVEY: NANTICOKE III #20
START TIME: 13:58 JUN 7 1979
SCAN TIME: 60 SEC
LOCATION: HWY#26, 1KM E DRY LAKE RD. (05869-47558); 19KM & 030D65/HYDRO

DURATION: 1.1 HRS
AVERAGING TIME: 5 MIN
Y DELAY: 0 MIN

NO POINTS= 13
COR COEFF=-0.32091

OZONE
MEAN = 0.0674
ST DEV= 0.0220

H2S
MEAN = 0.0027
ST DEV= 0.0018

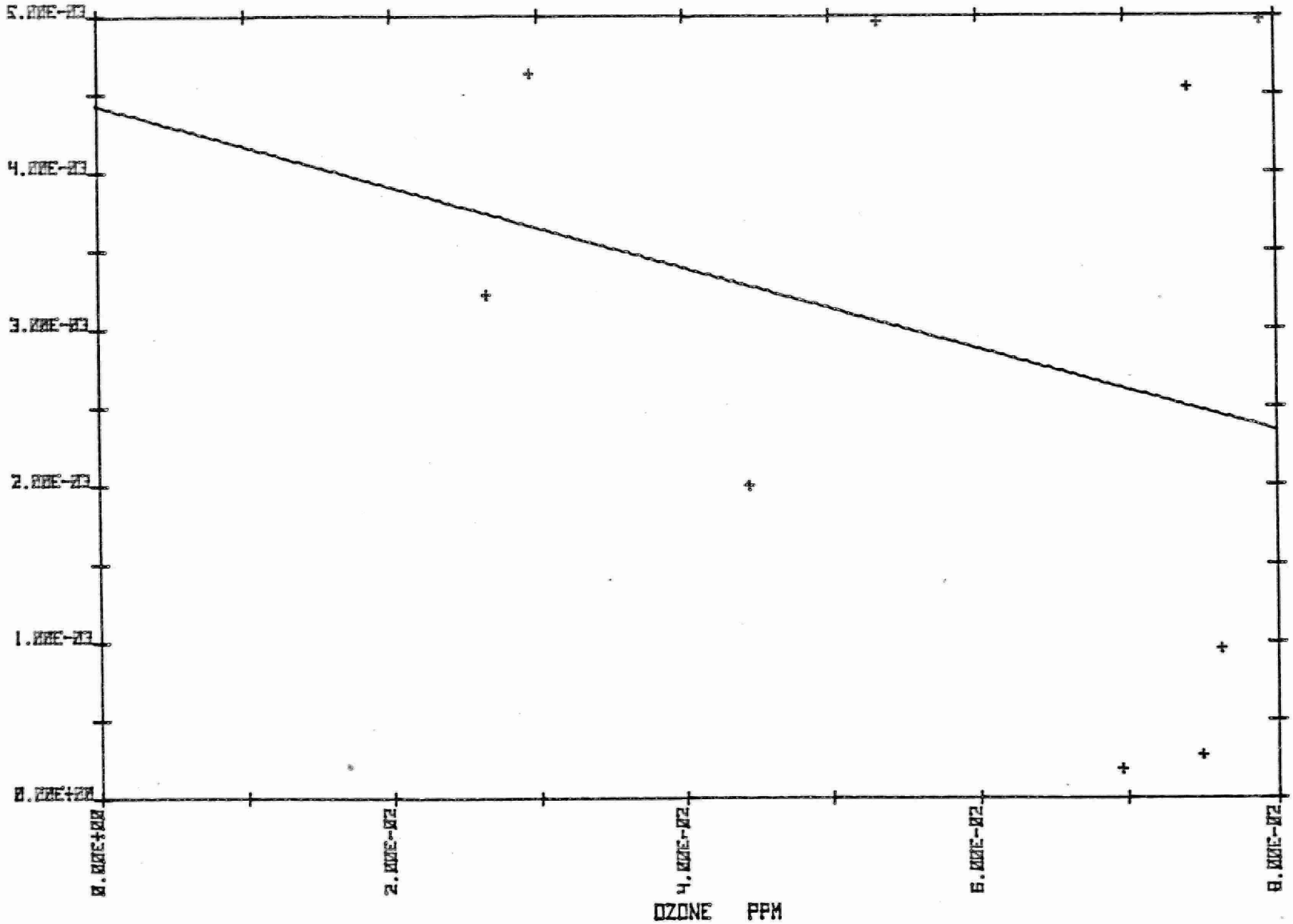


Figure 25

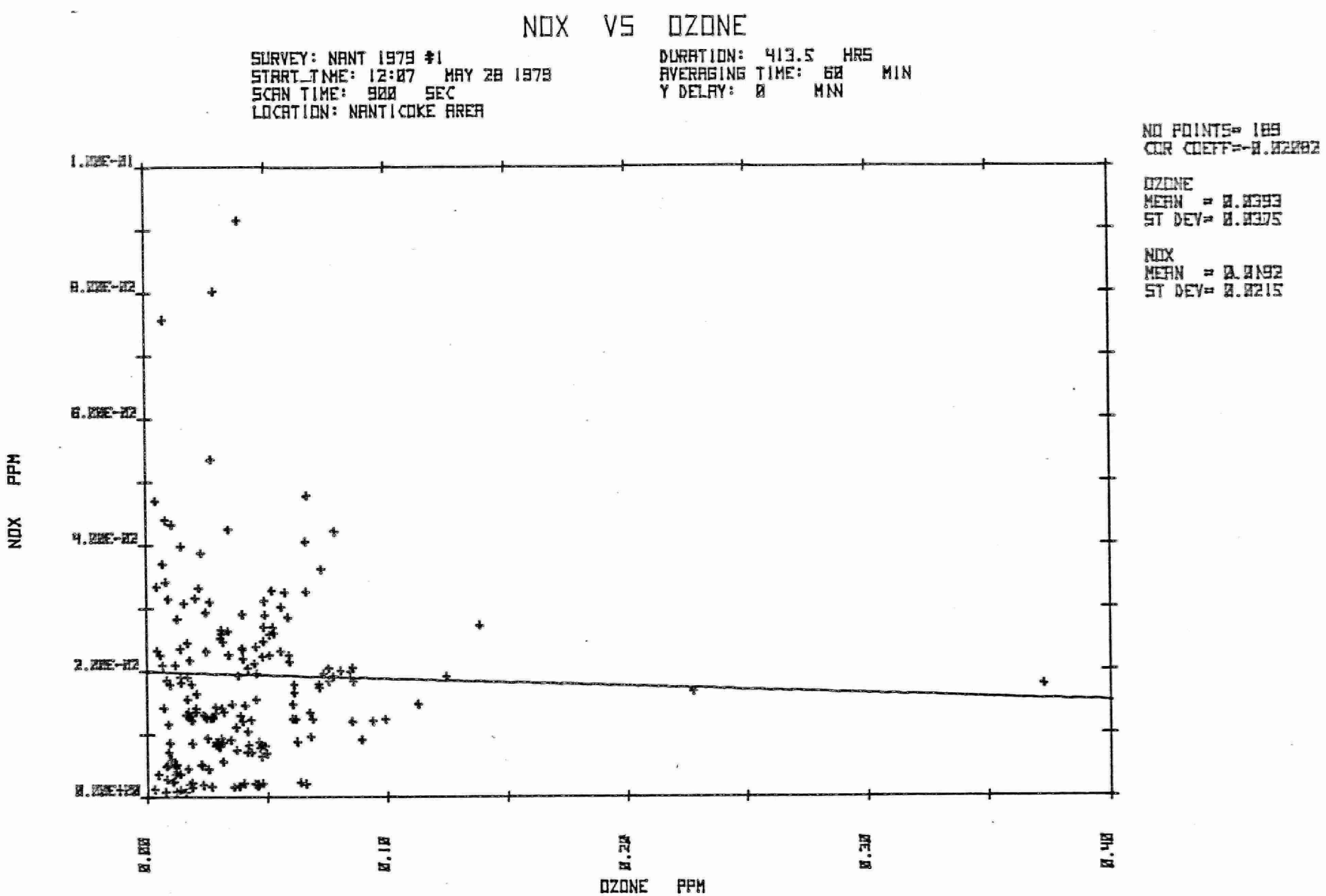

NOX VS OZONE
SURVEY: NANT 1979 #1
START_TIME: 12:07 MAY 28 1979
SCAN TIME: 900 SEC
LOCATION: NANTICOKE AREA
DURATION: 413.5 HRS
AVERAGING TIME: 60 MIN
Y DELAY: 0 MIN
NO POINTS= 189
COR COEFF=-0.02282
OZONE
MEAN = 0.0393
ST DEV= 0.0375
NOX
MEAN = 0.0192
ST DEV= 0.0215
NOX PPM
OZONE PPM

Figure 26

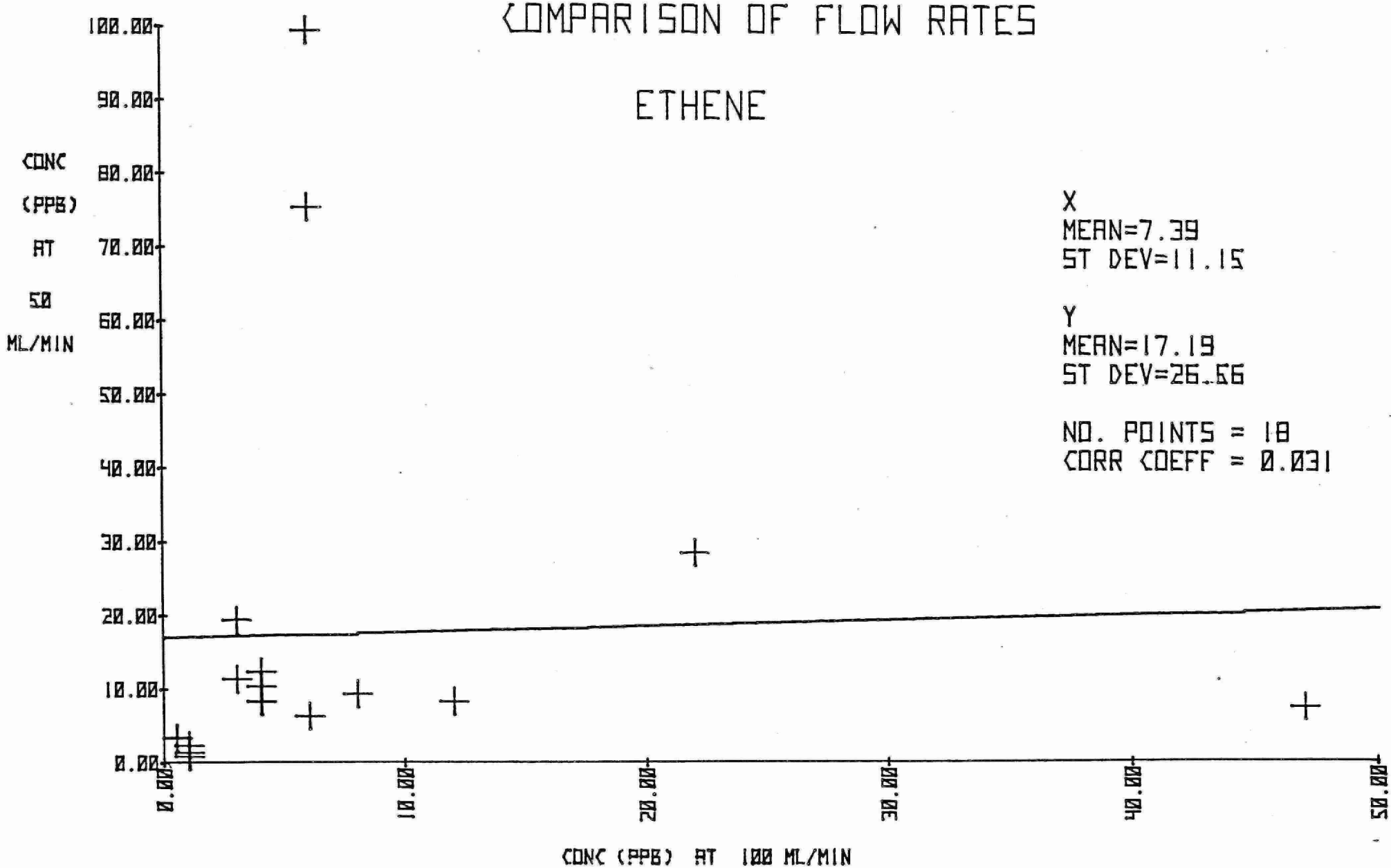

COMPARISON OF FLOW RATES
ETHENE
CONC (PPB) AT 50 ML/MIN
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
X
MEAN=7.39
ST DEV=11.15
Y
MEAN=17.19
ST DEV=26.56
NO. POINTS = 18
CORR COEFF = 0.031
0.00
10.00
20.00
30.00
40.00
50.00
CONC (PPB) AT 100 ML/MIN

Figure 27

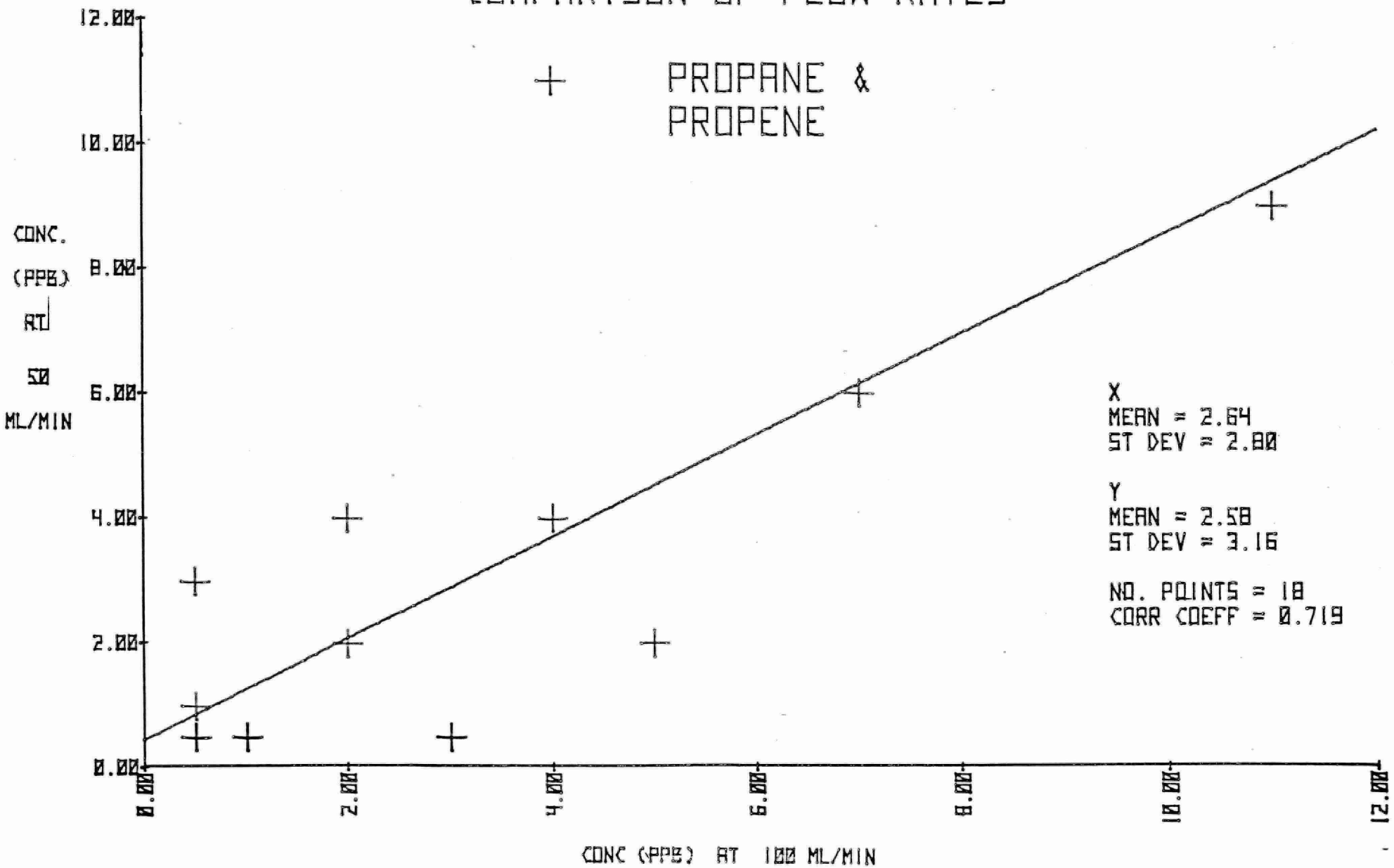

COMPARISON OF FLOW RATES
PROPANE &
PROPENE
CONC.
(PPB)
AT
50
ML/MIN
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0.00
2.00
4.00
6.00
8.00
10.00
12.00
CONC (PPB) AT 100 ML/MIN
X
MEAN = 2.64
ST DEV = 2.80
Y
MEAN = 2.58
ST DEV = 3.16
NO. POINTS = 18
CORR COEFF = 0.719

Figure 28

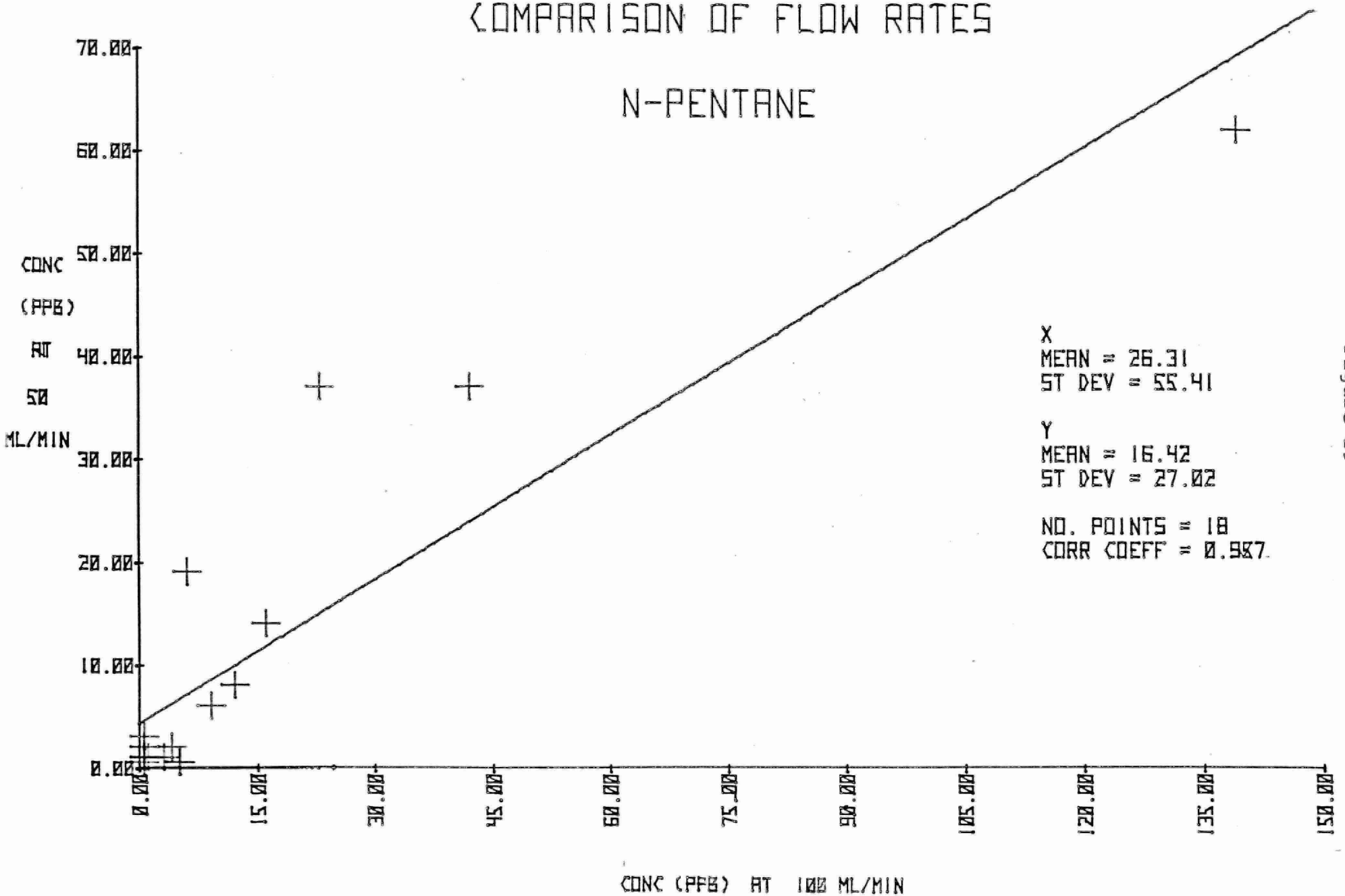

COMPARISON OF FLOW RATES
N-PENTANE
CONC (PPB) AT 50 ML/MIN
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
0.00
15.00
30.00
45.00
60.00
75.00
90.00
105.00
120.00
135.00
150.00
CONC (PPB) AT 100 ML/MIN
X
MEAN = 26.31
ST DEV = 55.41
Y
MEAN = 16.42
ST DEV = 27.02
NO. POINTS = 18
CORR COEFF = 0.987

Figure 29

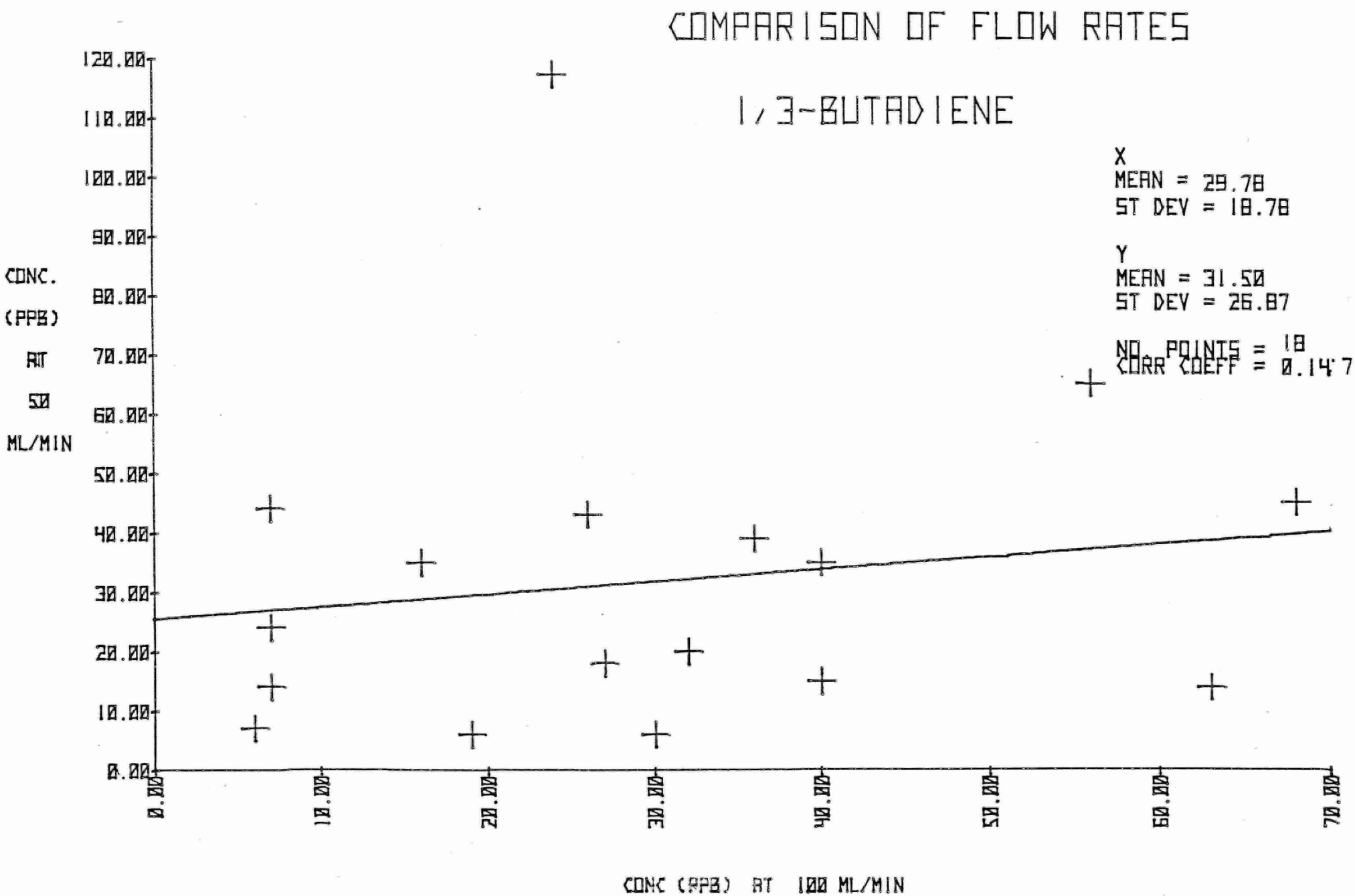

COMPARISON OF FLOW RATES
1,3-BUTADIENE
X
MEAN = 29.78
ST DEV = 18.78
Y
MEAN = 31.50
ST DEV = 26.87
NO. POINTS = 18
CORR COEFF = 0.147
CONC. (PPB) AT 50 ML/MIN
120.00
110.00
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
CONC (PPB) AT 100 ML/MIN

Figure 30

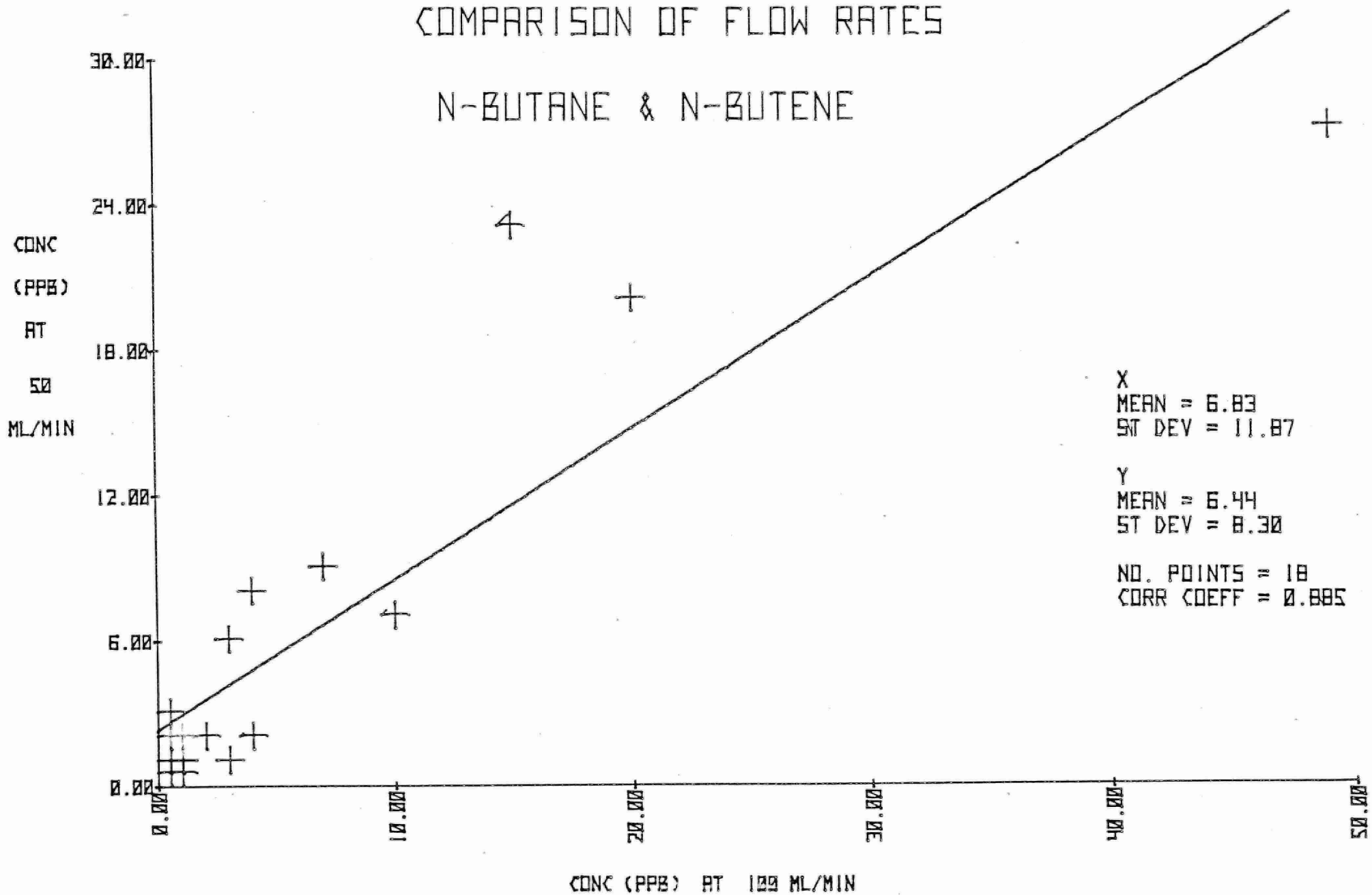

COMPARISON OF FLOW RATES
N-BUTANE & N-BUTENE
CONC (PPB) AT 50 ML/MIN
30.00
24.00
18.00
12.00
6.00
0.00
0.00
10.00
20.00
30.00
40.00
50.00
CONC (PPB) AT 100 ML/MIN
X
MEAN = 6.83
ST DEV = 11.87
Y
MEAN = 6.44
ST DEV = 8.30
NO. POINTS = 18
CORR COEFF = 0.885

Figure 31

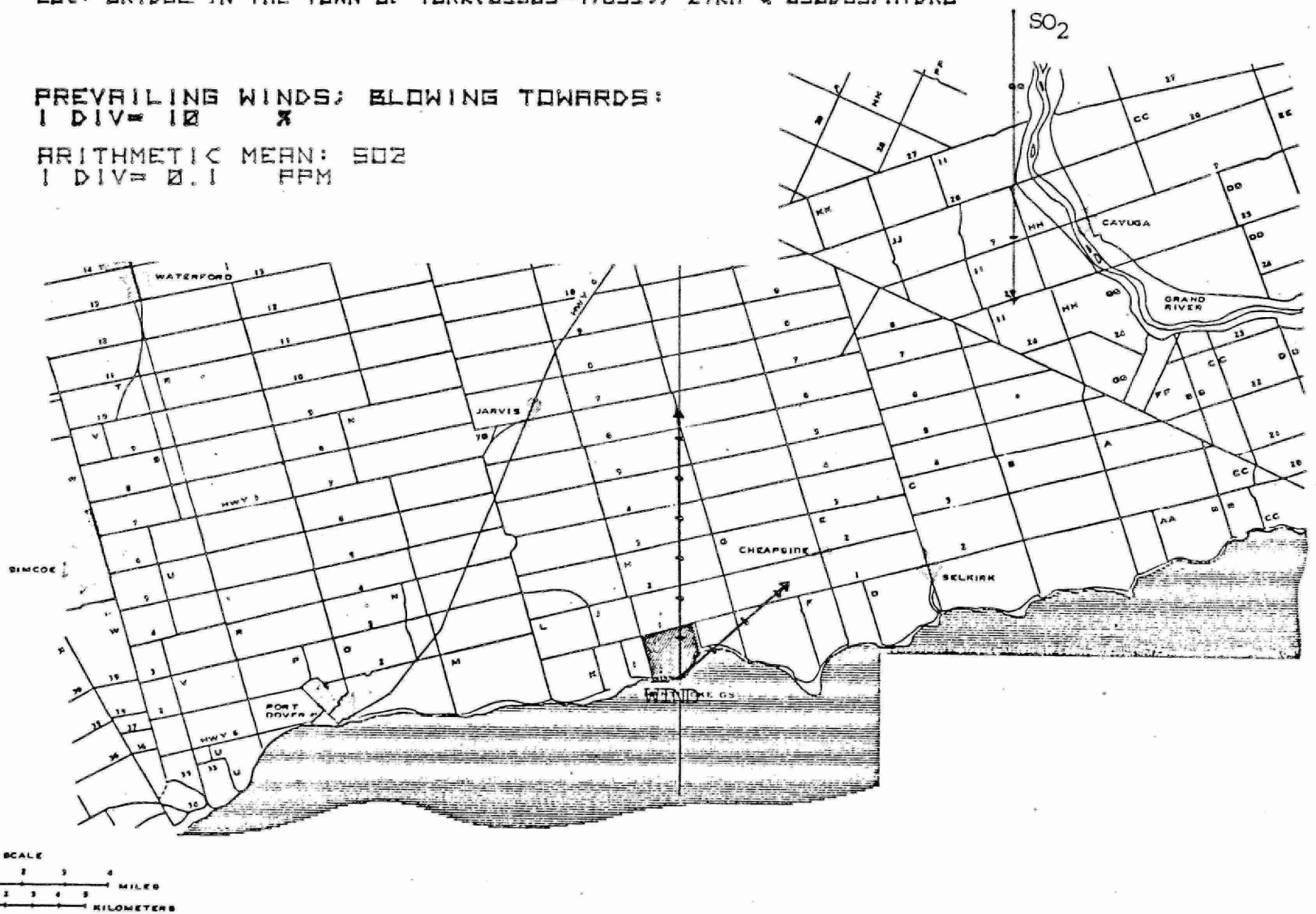
Map 5

NANTICOKE III #21

16:13 JUN 7 1979 SCAN= 60 SEC AVE= 30 MIN
LENGTH= 1.6 HRS MINIMUM MEAN= 1.000000E-03 PPM
DELAY= 0 MIN WIND RANGE= 0 / 7 KM/HR
LOC: BRIDGE IN THE TOWN OF YORK(05903-47635); 27KM & 030DGS/HYDRO

PREVAILING WINDS; BLOWING TOWARDS:
1 DIV= 10 %

ARITHMETIC MEAN: SO2
1 DIV= 0.1 PPM



NANTICOKE GS — AIR POLLUTION SURVEY AREA

Figure 32

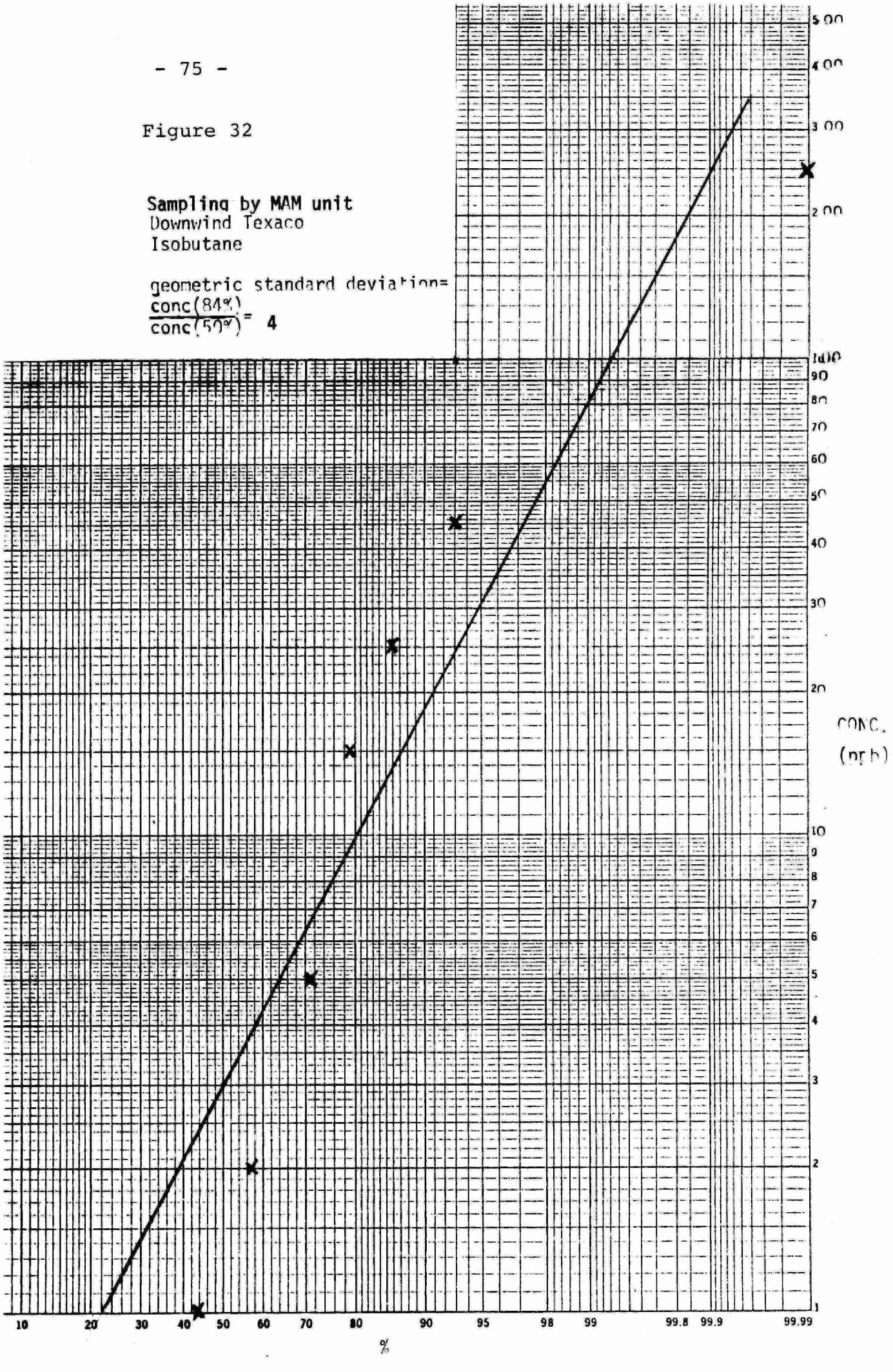

Sampling by MAM unit
Downwind Texaco
Isobutane
geometric standard deviation= conc(84%) / conc(50%) = 4
5 00
4 00
3 00
2 00
1000
900
800
700
600
500
400
300
200
100
90
80
70
60
50
40
30
20
10
9
8
7
6
5
4
3
2
1
CONC.
(ppb)
10
20
30
40
50
60
70
80
90
95
98
99
99.8
99.9
99.99
%

Figure 33

Sampling by MAM unit
Downwind Texaco
n-Butane and n-Butene

geometric standard deviation= $\frac{\text{conc}(84\%)}{\text{conc}(50\%)} = 3$

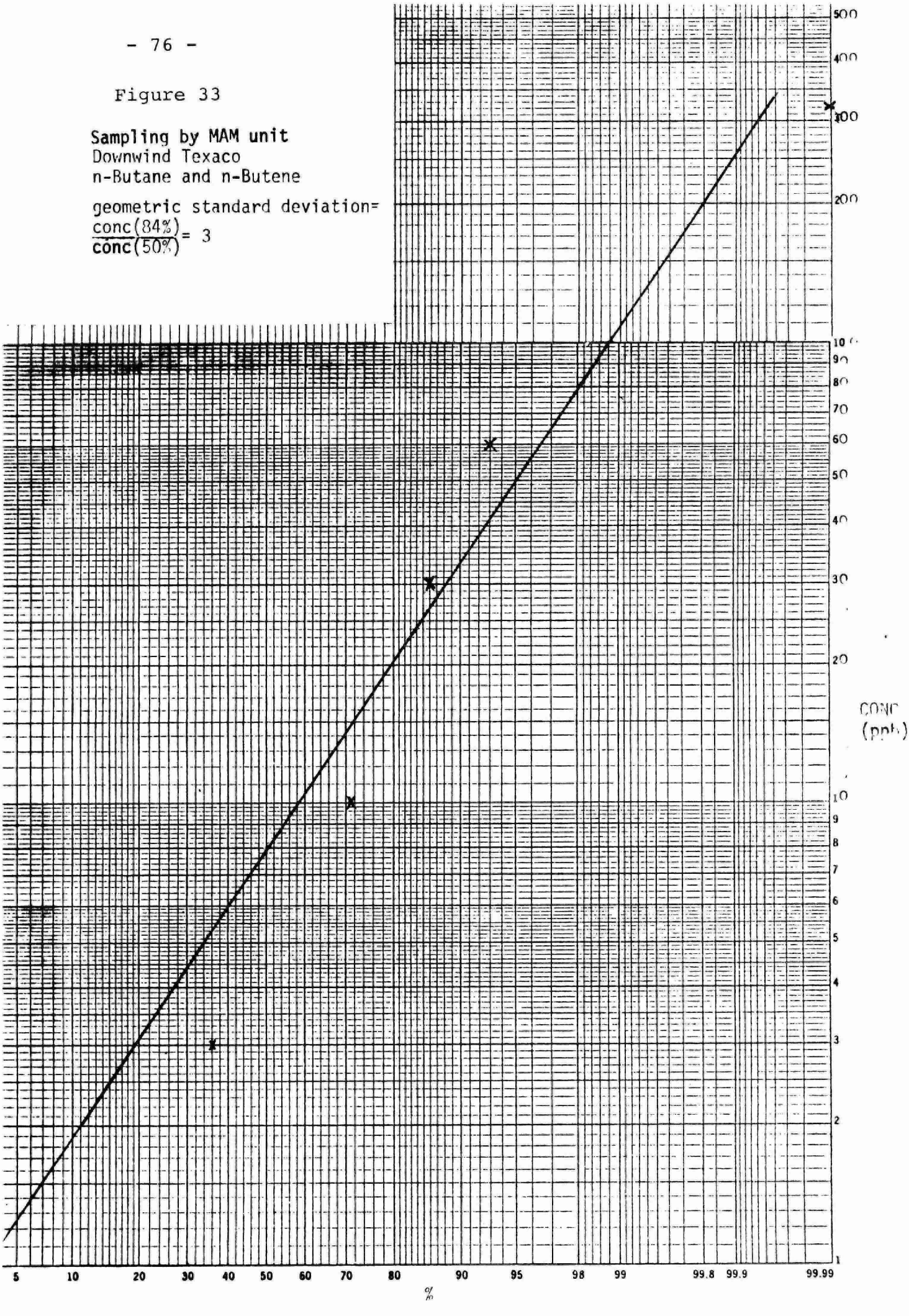


Figure 34

Field Sampling
Downwind
n-Pentane

geometric standard deviation= $\frac{\text{conc}(84\%)}{\text{conc}(50\%)} = 9$

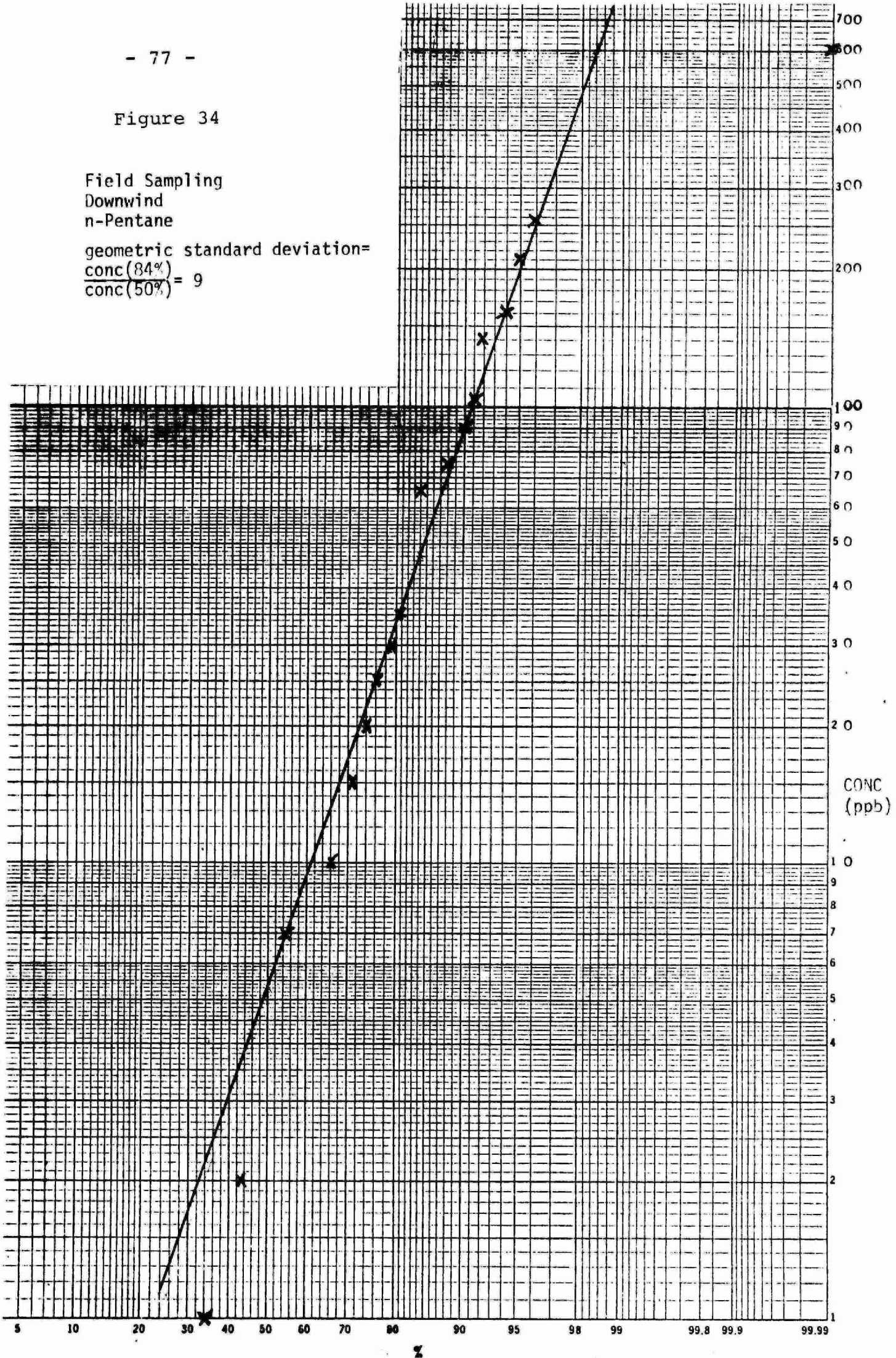


TABLE # 6a AMBIENT AIR SURVEY IN NANTICOKE 111 Units - PPM

GROUND LEVEL CONCENTRATIONS IN THE VICINITY OF NANTICOKE INDUSTRIAL COMPLEX

MONITORING LOCATION / NUMBER	DATE '79 May	MONITORING TIME START / END	INSTANTANEOUS CONCENTRATION SO_2		INSTANTANEOUS CONCENTRATION NO_x		MAXIMUM 30-MINUTE AVERAGE CONCENTRATION		MONITORING PERIOD AVERAGE CONCENTRATION		SCAN TIME
			Min.	Max.	Min.	Max.	SO_2	NO_x	SO_2	NO_x	Min.
NANTICOKE 111 # 1	28	1207 - 1355	0.001	0.037	0.001	0.176	0.009	0.035	0.003	0.019	1.0
" " # 2	29	1048 - 1254	0.001	0.021	0.001	0.270	0.014	0.083	0.005	0.030	3.0
" " # 3	29	1341 - 1501	0.006	0.146	0.008	0.087	0.052	0.038	0.025	0.024	1.0
" " # 4	30	1036 - 1351	0.007	0.026	0.021	0.836	0.015	0.200	0.011	0.111	1.0
" " # 5	30	1427 - 1515	0.014	0.161	0.010	0.102	0.050	0.020	0.043	0.017	1.0
" " # 6	30	1533 - 1630	0.009	0.072	0.012	0.054	0.024	0.023	0.017	0.019	1.0
" " # 7	30	1650 - 1741	0.012	0.070	0.001	0.083	0.035	0.032	0.027	0.032	1.0
" " # 8	30	1928 - 1410	0.001	0.050	0.001	0.138	0.035	0.050	0.009	0.027	3.0
" " # 9	31	1612 - 1927	0.001	0.014	0.010	0.048	0.012	0.033	0.003	0.020	3.0
" " #10	31	1931 - 1406	0.001	0.062	0.001	0.068	0.059	0.046	0.013	0.021	5.0
" " #11	June 2	1710 - 1813	0.016	0.143	0.009	0.029	0.091	0.019	0.057	0.015	1.5
" " #12	3	1628 - 1731	0.011	0.147	0.013	0.282	0.066	0.069	0.045	0.055	1.5
" " #13	4	1133 - 1327	0.008	0.025	0.014	0.027	0.016	0.018	0.013	0.017	1.5

COMMENTS;

TABLE # 6b

AMBIENT AIR SURVEY IN NANTICOKE 111

Units - PPM

GROUND LEVEL CONCENTRATIONS IN THE VICINITY OF NANTICOKE INDUSTRIAL COMPLEX

MONITORING LOCATION / NUMBER	DATE '79 June	MONITORING TIME START / END	INSTANTANEOUS CONCENTRATION SO_2		INSTANTANEOUS CONCENTRATION NO_x		MAXIMUM 30-MINUTE AVERAGE CONCENTRATION		MONITORING PERIOD AVERAGE CONCENTRATION		SCAN TIME
			Min.	Max.	Min.	Max.	SO_2	NO_x	SO_2	NO_x	Min.
NANTICOKE 111 #14	4	1350 - 1459	0.027	0.211	0.015	0.099	0.130	0.048	0.081	0.032	1.0
" " #16	4	1648 - 1742	0.021	0.202	0.018	0.077	0.140	0.047	0.101	0.038	1.5
" " #17	6	1539 - 1642	0.013	0.200	0.023	0.878	0.080	0.170	0.068	0.142	1.0
" " #18	6	1749 - 1044	0.001	0.058	0.001	0.094	0.056	0.088	0.018	0.032	5.0
" " #19	7	1217 - 1317	0.023	0.103	0.002	0.006	0.067	0.003	0.046	0.002	1.0
" " #20	7	1358 - 1504	0.019	0.354	0.002	0.016	0.190	0.008	0.123	0.005	1.0
" " #21	7	1613 - 1749	0.065	0.267	0.004	0.074	0.160	0.018	0.123	0.014	1.0
" " #22	8	0531 - 0628	0.001	0.352	0.001	0.008	0.170	0.002	0.154	0.002	1.0
" " #23	8	1341 - 1456	0.010	0.037	0.001	0.005	0.031	0.002	0.022	0.002	1.0
" " #24	8	2138 - 0828	0.001	0.003	0.001	0.004	0.002	0.002	0.001	0.002	5.0
" " #25	9	1037 - 1234	0.005	0.029	0.017	0.234	0.019	0.050	0.012	0.029	1.0
" " #26	9	1331 - 0906	0.001	0.018	0.012	0.060	0.014	0.035	0.007	0.021	5.0
" " #27	10	1014 - 0829	0.001	0.011	0.001	0.022	0.011	0.020	0.002	0.013	5.0

COMMENTS;

TABLE # 6c AMBIENT AIR SURVEY IN NANTICOKE 111 Units - PPM

GROUND LEVEL CONCENTRATIONS IN THE VICINITY OF NANTICOKE INDUSTRIAL COMPLEX

MONITORING LOCATION / NUMBER	DATE '79 June	MONITORING TIME START / END	INSTANTANEOUS CONCENTRATION SO_2 Min.	INSTANTANEOUS CONCENTRATION SO_2 Max.	INSTANTANEOUS CONCENTRATION NO_x Min.	INSTANTANEOUS CONCENTRATION NO_x Max.	MAXIMUM 30-MINUTE AVERAGE CONCENTRATION SO_2	MAXIMUM 30-MINUTE AVERAGE CONCENTRATION NO_x	MONITORING PERIOD AVERAGE CONCENTRATION SO_2	MONITORING PERIOD AVERAGE CONCENTRATION NO_x	SCAN TIME Min.
NANTICOKE 111 #28	11	1129 - 0554	0.001	0.003	0.005	0.025	0.003	0.018	0.002	0.011	5.0
" " #29	12	1011 - 1126	0.001	0.001	0.008	0.044	0.001	0.021	0.001	0.015	1.5
" " #31	12	1402 - 1517	0.001	0.001	0.004	0.029	0.001	0.013	0.001	0.011	1.0
" " #32	12	1534 - 1716	0.001	0.004	0.005	0.013	0.001	0.007	0.001	0.007	1.0
" " #33	13	1458 - 1558	0.022	0.166	0.013	0.079	0.090	0.042	0.077	0.037	1.0
" " #34	13	1642 - 1818	0.038	0.195	0.014	0.102	0.140	0.052	0.113	0.041	1.0
" " #37	14	1438 - 1522	0.001	0.546	0.001	0.271	0.330	0.150	0.244	0.113	1.0
" " #38	14	1714 - 1801	0.065	0.248	0.045	0.239	0.180	0.100	0.157	0.092	1.0

COMMENTS;

TABLE # 7a

AMBIENT AIR SURVEY IN NANTICOKE 111

Units - PPM

GROUND LEVEL CONCENTRATIONS IN THE VICINITY OF the Nanticoke Industrial Complex

MONITORING LOCATION / NUMBER	DATE May 1979	MONITORING TIME START / END	INSTANTANEOUS CONCENTRATION				MAXIMUM 30-MINUTE AVERAGE CONCENTRATION		MONITORING PERIOD AVERAGE CONCENTRATION		SCAN TIME
			THC		H_2S						
			Min.	Max.	Min.	Max.	THC	H_2S	THC	H_2S	Min.
NANTICOKE 111 # 1	28	1207 - 1355	0.001	5.17	0.001	0.002	2.5	0.001	1.84	0.001	1.0
" " # 2	29	1048 - 1254	0.001	4.24	0.001	0.001	2.0	0.001	1.25	0.001	3.0
" " # 3	29	1341 - 1501	1.43	1.66	0.001	0.004	1.5	0.002	1.47	0.002	1.0
" " # 4	30	1036 - 1351	1.39	7.55	0.001	0.004	2.2	0.002	1.79	0.002	1.0
" " # 5	30	1427 - 1515	1.39	1.78	0.001	0.004	1.5	0.003	1.44	0.002	1.0
" " # 6	30	1533 - 1630	1.36	1.88	0.001	0.003	1.4	0.001	1.42	0.001	1.0
" " # 7	30	1650 - 1741	1.35	1.65	0.001	0.003	1.4	0.002	1.41	0.002	1.0
# 8	30	1928 - 1410	1.43	7.12	0.001	0.006	3.9	0.004	2.10	0.003	3.0
" " # 9	31	1612 - 1927	1.35	7.97	0.001	0.003	2.3	0.003	1.59	0.002	3.0
" " #10	31	1931 - 1406	1.25	2.77	0.001	0.006	2.0	0.006	1.56	0.003	5.0
" " #11	June 2	1710 - 1813	0.529	0.581	0.001	0.001	0.560	0.001	0.549	0.001	1.5
" " #12	3	1628 - 1731	0.953	23.3	0.004	0.007	5.5	0.006	4.79	0.005	1.5
" " #13	4	1133 - 1327	0.45	0.757	0.001	0.003	0.570	0.001	0.545	0.001	1.5

COMMENTS;

TABLE # 7b AMBIENT AIR SURVEY IN NANTICOKE 111 Units - PPM

GROUND LEVEL CONCENTRATIONS IN THE VICINITY OF the Nanticoke Industrial Complex

MONITORING LOCATION / NUMBER	DATE June 1979	MONITORING TIME START / END	INSTANTANEOUS CONCENTRATION THC Min.	INSTANTANEOUS CONCENTRATION THC Max.	INSTANTANEOUS CONCENTRATION H_2S Min.	INSTANTANEOUS CONCENTRATION H_2S Max.	MAXIMUM 30-MINUTE AVERAGE CONCENTRATION THC	MAXIMUM 30-MINUTE AVERAGE CONCENTRATION H_2S	MONITORING PERIOD AVERAGE CONCENTRATION THC	MONITORING PERIOD AVERAGE CONCENTRATION H_2S	SCAN TIME Min.
NANTICOKE 111 #14	4	1350 - 1459	0.409	0.723	0.001	0.003	0.570	0.002	0.562	0.002	1.0
" " #16	4	1648 - 1742	0.677	0.792	0.001	0.001	0.770	0.001	0.749	0.001	1.5
" " #17	6	1539 - 1642	1.51	8.53	0.004	0.014	2.2	0.010	2.02	0.008	1.0
#18	6	1749 - 1044	0.001	3.25	0.001	0.009	2.2	0.009	1.30	0.003	5.0
" " #19	7	1217 - 1317	1.43	1.86	0.001	0.001	1.5	0.001	1.49	0.001	1.0
" " #20	7	1358 - 1504	1.27	1.36	0.001	0.006	1.3	0.004	1.32	0.003	1.0
" " #21	7	1613 - 1749	1.30	17.3	0.001	0.003	3.2	0.002	2.51	0.002	1.0
" " #22	8	0531 - 0628	0.001	1.97	0.001	0.016	1.4	0.001	1.36	0.001	1.0
" " #23	8	1341 - 1456	0.578	1.15	0.001	0.002	0.98	0.001	0.786	0.001	1.0
" " #24	8	2138 - 0828	0.456	2.85	0.001	0.002	1.9	0.002	0.714	0.001	5.0
" " #25	9	1037 - 1234	1.67	4.89	0.001	0.019	2.8	0.005	2.52	0.004	1.0
" " #26	9	1331 - 0906	0.001	6.38	0.001	0.002	2.6	0.001	1.71	0.001	5.0
" " #27	10	1014 - 0829	0.001	1.67	0.001	0.027	1.6	0.017	1.29	0.002	5.0

COMMENTS;

TABLE # 7c

AMBIENT AIR SURVEY IN NANTICOKE 111

Units - PPM

GROUND LEVEL CONCENTRATIONS IN THE VICINITY OF the Nanticoke Industrial Complex

MONITORING LOCATION / NUMBER	DATE June 1979	MONITORING TIME START / END	INSTANTANEOUS CONCENTRATION THC Min.	INSTANTANEOUS CONCENTRATION THC Max.	INSTANTANEOUS CONCENTRATION H_2S Min.	INSTANTANEOUS CONCENTRATION H_2S Max.	MAXIMUM 30-MINUTE AVERAGE CONCENTRATION THC	MAXIMUM 30-MINUTE AVERAGE CONCENTRATION H_2S	MONITORING PERIOD AVERAGE CONCENTRATION THC	MONITORING PERIOD AVERAGE CONCENTRATION H_2S	SCAN TIME Min.
NANTICOKE 111 #28	11	1129 - 0554	0.758	5.77	0.001	0.006	2.3	0.006	1.01	0.002	5.0
" " #29	12	1011 - 1126	1.21	2.20	0.001	0.001	1.4	0.001	1.28	0.001	1.5
" " #31	12	1402 - 1517	1.85	4.07	0.001	0.001	2.1	0.001	1.98	0.001	1.0
" " #32	12	1534 - 1716	1.86	17.3	0.001	0.001	4.6	0.001	3.22	0.001	1.0
" " #33	13	1458 - 1558	0.727	1.22	0.001	0.001	0.92	0.001	0.845	0.001	1.0
" " #34	13	1642 - 1818	0.674	0.812	0.001	0.006	0.80	0.005	0.775	0.003	1.0
" " #37	14	1438 - 1522	0.001	2.19	0.001	0.004	1.8	0.002	1.51	0.001	1.0
" " #38	14	1714 - 1801	2.03	3.05	0.001	0.003	2.2	0.001	2.15	0.001	1.0

COMMENTS;

TABLE # 8a

AMBIENT AIR SURVEY IN NANTICOKE 111

Units - PPM

GROUND LEVEL CONCENTRATIONS IN THE VICINITY OF NANTICOKE INDUSTRIAL COMPLEX

MONITORING LOCATION / NUMBER	DATE '79 May	MONITORING TIME START / END	INSTANTANEOUS CONCENTRATION Ozone				MAXIMUM 30-MINUTE AVERAGE CONCENTRATION		MONITORING PERIOD AVERAGE CONCENTRATION		SCAN TIME
			Min.	Max.	Min.	Max.	Ozone		Ozone		Min.
NANTICOKE 111 # 1	28	1207 - 1355	0.001	0.414			0.380		0.333		1.0
" " # 2	29	1048 - 1254	0.001	0.037			0.035		0.023		3.0
" " # 3	29	1341 - 1501	0.010	0.043			0.040		0.034		1.0
" " # 4	30	1036 - 1351	0.008	0.051			0.042		0.037		1.0
" " # 5	30	1427 - 1515	0.046	0.056			0.052		0.052		1.0
" " # 6	30	1533 - 1630	0.030	0.056			0.052		0.050		1.0
" " # 7	30	1650 - 1741	0.034	0.055			0.052		0.049		1.0
" " # 8	30	1928 - 1410	0.001	0.084			0.056		0.023		3.0
" " # 9	31	1612 - 1927	0.106	0.152			0.140		0.126		3.0
" " #10	31	1931 - 1406	0.041	0.105			0.100		0.071		5.0
" " #11	June 2	1710 - 1813	0.038	0.055			0.052		0.049		1.5
" " #12	3	1628 - 1731	0.078	0.100			0.091		0.089		1.5
" " #13	4	1133 - 1327	0.064	0.088			0.083		0.076		1.5

COMMENTS;

TABLE # 8b AMBIENT AIR SURVEY IN NANTICOKE 111 Units - PPM

GROUND LEVEL CONCENTRATIONS IN THE VICINITY OF NANTICOKE INDUSTRIAL COMPLEX

MONITORING LOCATION / NUMBER	DATE '79 June	MONITORING TIME START / END	INSTANTANEOUS CONCENTRATION Ozone				MAXIMUM 30-MINUTE AVERAGE CONCENTRATION		MONITORING PERIOD AVERAGE CONCENTRATION		SCAN TIME
			Min.	Max.	Min.	Max.	Ozone		Ozone		Min.
NANTICOKE 111 #14	4	1350 - 1459	0.046	0.097			0.090		0.077		1.0
" " #16	4	1648 - 1742	0.053	0.094			0.083		0.076		1.5
" " #17	6	1539 - 1642	0.012	0.049			0.040		0.036		1.0
" " #18	6	1749 - 1044	0.001	0.050			0.049		0.016		5.0
" " #19	7	1217 - 1317	0.072	0.094			0.092		0.087		1.0
" " #20	7	1358 - 1504	0.018	0.097			0.074		0.068		1.0
" " #21	7	1613 - 1749	0.014	0.066			0.049		0.044		1.0
" " #22	8	0531 - 0628	0.001	0.030			0.024		0.024		1.0
" " #23	8	1341 - 1456	0.058	0.042			0.068		0.064		1.0
" " #24	8	2138 - 0828	0.011	0.052			0.050		0.037		5.0
" " #25	9	1037 - 1234	0.027	0.060			0.055		0.049		1.0
" " #26	9	1331 - 0906	0.013	0.063			0.062		0.038		5.0
" " #27	10	1014 - 0829	0.001	0.089			0.087		0.050		5.0

COMMENTS;

TABLE # 8c AMBIENT AIR SURVEY IN NANTICOKE 111 Units - PPM

GROUND LEVEL CONCENTRATIONS IN THE VICINITY OF NANTICOKE INDUSTRIAL COMPLEX

MONITORING LOCATION / NUMBER	DATE '79 June	MONITORING TIME START / END	INSTANTANEOUS CONCENTRATION Ozone				MAXIMUM 30-MINUTE AVERAGE CONCENTRATION		MONITORING PERIOD AVERAGE CONCENTRATION		SCAN TIME
			Min.	Max.	Min.	Max.	Ozone		Ozone		Min.
NANTICOKE 111 #28	11	1129 - 0554	0.015	0.051			0.050		0.034		5.0
" " #29	12	1011 - 1126	0.028	0.040			0.037		0.035		1.5
" " #31	12	1402 - 1517	0.035	0.043			0.040		0.040		1.0
" " #32	12	1534 - 1716	0.037	0.044			0.042		0.041		1.0
" " #33	13	1458 - 1558	0.022	0.053			0.042		0.040		1.0
" " #34	13	1642 - 1818	0.019	0.051			0.038		0.035		1.0
" " #37	14	1438 - 1522	0.000	0.077			0.028		0.024		1.0
" " #38	14	1714 - 1801	0.040	0.084			0.068		0.062		1.0

COMMENTS;

Table # 9a G. C. HYDROCARBON DATA UNITS- PPB

Method: Sampling by MAM unit (direct injection) Location: Downwind Hydro

RUN #	ETHENE	ACETYLENE	PROPANE & PROPENE	CYCLO-PROPANE	ISO-BUTANE	n-BUTANE &n-BUTENE	1,3-BUTA-DIENE	2,2-DI-METHYL-PROPANE	n-PENTANE	3-METHYL-BUTENE	n-HEXANE	BENZENE	n-HEPTANE	TOLUENE
17	ND	10	15	ND	ND	ND	4	ND	20	20	21	7	ND	9
18	3	ND	2	ND	1	2	ND	ND	1	ND	ND	3	ND	ND
19	8	ND	14	ND	ND	2	2	ND	ND	ND	ND	3	ND	ND
32	10	ND	6	ND	1	4	15	ND	1	1	ND	3	4	12
33	2	ND	ND	ND	2	2	ND	ND	3	1	4	3	ND	32
34	10	ND	ND	ND	ND	2	10	ND	ND	1	ND	ND	ND	1
35	3	ND	4	ND	ND	2	9	ND	ND	ND	7	ND	ND	31

ND - not detectable

Table # 9b

G. C. HYDROCARBON DATA

UNITS- PPB

Method: Sampling by MAM unit (direct injection)

Location: Downwind Texaco

RUN #	ETHENE	ACETYLENE	PROPANE & PROPENE	CYCLO-PROPANE	ISO-BUTANE	n-BUTANE &n-BUTENE	1,3-BUTA-DIENE	2,2-DI-METHYL-PROPANE	n-PENTANE	3-METHYL-BUTENE	n-HEXANE	BENZENE	n-HEPTANE	TOLUENE
1	1	ND	4	ND	1	3	4	ND	ND	ND	1	ND	ND	ND
2	ND	"	11	"	12	17	3	"	20	3	3	"	"	8
3	ND	"	12	"	ND	56	3	"	26	47	4	"	"	4
4	5	"	18	"	24	312	3	"	34	ND	5	1	"	ND
5	ND	"	9	7	243	23	3	"	2	3	ND	1	"	ND
6	4	"	6	ND	42	9	1	"	4	5	77	ND	"	ND
31A	11	6	8	"	3	8	11	"	8	2	7	10	4	37
63	32	ND	3	"	1	8	15	"	19	ND	5	ND	ND	ND
74	2	"	ND	"	ND	2	35	"	1	"	ND	"	"	ND
103	ND	"	8	"	3	4	ND	"	3	"	"	"	"	10
104	ND	"	ND	"	ND	2	ND	"	1	"	"	"	"	2
105	ND	"	ND	"	1	3	ND	"	3	"	"	"	"	6
106	3	"	ND	"	2	2	ND	"	5	"	7	"	"	ND
107	ND	"	ND	"	2	5	1	"	17	6	28	"	"	72

ND - not detectable

Table # 9c

G. C. HYDROCARBON DATA

UNITS- PPB

Method: Sampling by MAM unit (direct injection)

Location: Upwind

RUN #	ETHENE	ACETYLENE	PROPANE & PROPENE	CYCLO-PROPANE	ISO-BUTANE	n-BUTANE &n-BUTENE	1,3-BUTA-DIENE	2,2-DI-METHYL-PROPANE	n-PENTANE	3-METHYL-BUTENE	n-HEXANE	BENZENE	n-HEPTANE	TOLUENE
61	19	7	ND	ND	ND	2	9	ND	19	ND	5	ND	ND	1
62	4	ND	3	ND	ND	3	12	ND	8	ND	3	2	ND	1

ND - not detectable

Table # 9d G. C. HYDROCARBON DATA UNITS- PPB

Method: Airborne Cartridge Sampling Location: Hydro Plume

RUN #	ETHENE	ACETYLENE	PROPANE & PROPENE	CYCLO-PROPANE	ISO-BUTANE	n-BUTANE &n-BUTENE	1,3-BUTA-DIENE	2,2-DI-METHYL-PROPANE	n-PENTANE	3-METHYL-BUTENE	n-HEXANE	BENZENE	n-HEPTANE	TOLUENE
58	16	ND	ND	ND	ND	5	24	ND	5	ND	4	1	ND	ND
76	54	"	45	"	"	32	1621	"	10	635	66	ND	"	"
77	2	"	ND	"	"	1	210	"	ND	35	ND	"	"	"
154	1	"	"	"	"	1	16	"	"	ND	"	"	"	"
156	9	"	"	"	"	2	19	"	1	"	"	"	"	"

ND - not detectable

Table # 9e — G. C. HYDROCARBON DATA — UNITS- PPB

Method: Airborne Cartridge Sampling — Location: Texaco Plume

RUN #	ETHENE	ACETYLENE	PROPANE & PROPENE	CYCLO-PROPANE	ISO-BUTANE	n-BUTANE &n-BUTENE	1,3-BUTA-DIENE	2,2-DI-METHYL-PROPANE	n-PENTANE	3-METHYL-BUTENE	n-HEXANE	BENZENE	n-HEPTANE	TOLUENE
7	153	ND	32	ND	2	15	364	ND	ND	36	3	ND	ND	ND
9	98	"	10	"	ND	3	77	"	2	17	ND	"	"	"
111	31	"	ND	"	"	2	28	"	ND	ND	"	"	"	"
112	61	"	ND	"	"	2	85	"	ND	"	"	"	"	"
113	57	"	ND	"	"	3	116	"	ND	"	"	"	"	"

ND - not detectable

Table # 9f

G. C. HYDROCARBON DATA

UNITS- PPB

Method: Airborne Cartridge Sampling

Location: Upwind

RUN #	ETHENE	ACETYLENE	PROPANE & PROPENE	CYCLO-PROPANE	ISO-BUTANE	n-BUTANE &n-BUTENE	1,3-BUTA-DIENE	2,2-DI-METHYL-PROPANE	n-PENTANE	3-METHYL-BUTENE	n-HEXANE	BENZENE	n-HEPTANE	TOLUENE
8	51	ND	4	ND	ND	ND	115	ND	ND	ND	ND	ND	ND	ND
22	598	"	19	"	1	6	110	"	"	19	4	1	1	1
23	74	"	5	"	ND	3	69	"	"	ND	ND	ND	ND	ND
82	415	"	ND	"	ND	2	51	"	"	"	ND	ND	ND	ND
110	162	"	"	"	"	15	ND	"	"	"	ND	"	"	ND
114	191	"	"	"	"	ND	24	"	"	"	"	"	"	"
139	38	"	13	"	"	6	238	"	"	15	"	3	8	"

ND - not detectable

Table # 9 g — G. C. HYDROCARBON DATA — UNITS- PPB

Method: Airborne Cartridge Sampling — Location: Helicopter exhaust

RUN #	ETHENE	ACETYLENE	PROPANE & PROPENE	CYCLO-PROPANE	ISO-BUTANE	n-BUTANE &n-BUTENE	1,3-BUTA-DIENE	2,2-DI-METHYL-PROPANE	n-PENTANE	3-METHYL-BUTENE	n-HEXANE	BENZENE	n-HEPTANE	TOLUENE
21	241	ND	19	ND	12	8	75	ND	ND	ND	ND	ND	ND	7
38	717	ND	42	ND	13	35	181	ND	68	ND	97	8	ND	ND

ND - not detectable

Table # 9h G. C. HYDROCARBON DATA UNITS- PPB

Method: Field Cartridge Sampling Location: Upwind

RUN #	ETHENE	ACETYLENE	PROPANE & PROPENE	CYCLO-PROPANE	ISO-BUTANE	n-BUTANE &n-BUTENE	1,3-BUTA-DIENE	2,2-DI-METHYL-PROPANE	n-PENTANE	3-METHYL-BUTENE	n-HEXANE	BENZENE	n-HEPTANE	TOLUENE
14	16	ND	2	ND	1	2	6	ND	ND	ND	ND	ND	ND	ND
15	3	"	ND	"	ND	1	1	"	"	"	"	"	"	"
25	48	"	10	"	"	11	51	"	"	"	"	1	"	"
29	23	"	4	"	1	7	9	"	3	"	7	ND	"	"
30	724	"	19	"	3	9	69	"	9	24	23	"	"	3
31b	14	8	15	"	ND	13	83	"	9	ND	ND	1	"	ND
40b	42	ND	26	"	3	6	32	"	20	ND	13	10	1	"
49	5	"	ND	"	ND	1	10	"	ND	1	ND	ND	ND	"
56	ND	"	"	"	4	ND	1	"	"	ND	"	"	"	"
57	"	"	"	"	ND	1	ND	"	"	"	"	"	"	"
68	4	"	"	"	"	2	9	"	"	"	"	"	"	"
85	3	"	2	"	"	1	27	"	"	"	"	"	"	"
86	3	"	1	"	16	ND	ND	"	"	"	"	"	"	"
87	11	"	4	"	ND	2	18	"	"	"	"	"	"	"
133	6	"	ND	"	"	ND	20	"	"	"	"	"	"	"
134	19	"	2	"	"	1	43	"	"	"	"	"	"	"

ND - not detectable

Table # 9h (cont'd) G. C. HYDROCARBON DATA UNITS- PPB

Method: Field Cartridge Sampling Location: Upwind

RUN #	ETHENE	ACETYLENE	PROPANE & PROPENE	CYCLO-PROPANE	ISO-BUTANE	n-BUTANE &n-BUTENE	1,3-BUTA-DIENE	2,2-DI-METHYL-PROPANE	n-PENTANE	3-METHYL-BUTENE	n-HEXANE	BENZENE	n-HEPTANE	TOLUENE
137	6	ND	3	ND	1	1	32	ND	ND	ND	ND	ND	ND	ND
138	3	"	2	"	ND	ND	26	"	"	ND	"	"	"	"
141	ND	"	4	"	6	20	38	"	99	48	"	2	"	"
142	3	ND	3	"	3	6	44	ND	37	ND	ND	ND	ND	ND
143	1	ND	11	"	4	23	65	"	37	72	"	4	"	"
144	10	"	ND	"	ND	3	4	"	7	ND	"	ND	"	"
150	ND	"	"	"	1	3	7	"	23	"	"	1	"	"
151	1	"	4	"	3	15	56	"	42	44	"	4	"	"

ND - not detectable

Table # 9i — G. C. HYDROCARBON DATA — UNITS- PPB

Method: Field Cartridge Sampling — Location: Downwind

RUN #	ETHENE	ACETYLENE	PROPANE & PROPENE	CYCLO-PROPANE	ISO-BUTANE	n-BUTANE &n-BUTENE	1,3-BUTA-DIENE	2,2-DI-METHYL-PROPANE	n-PENTANE	3-METHYL-BUTENE	n-HEXANE	BENZENE	n-HEPTANE	TOLUENE
11	11	ND	26	ND	96	316	32	ND	158	4	60	1	ND	3
12	4	"	17	"	158	516	14	"	252	8	106	69	"	ND
27	38	"	1	"	ND	ND	24	"	ND	ND	ND	ND	"	"
28	29	"	9	"	1	4	61	"	"	"	"	ND	"	1
41	76	"	3	"	1	21	35	"	35	12	8	1	"	2
42	4	"	8	"	4	6	30	"	27	8	13	2	"	1
50	29	"	2	"	1	5	2	"	1	ND	ND	ND	"	ND
51	9	"	1	"	ND	12	15	"	1	"	"	"	"	"
52	4	4	2	"	17	ND	4	8	ND	"	"	"	"	"
53	9	ND	2	"	12	"	ND	4	"	"	3	"	"	"
54	8	2	1	"	5	3	ND	1	"	"	2	"	"	"
55	7	ND	1	"	1	4	1	ND	1	3	ND	"	"	"
65	2	"	5	"	ND	9	59	"	72	86	124	931	"	162
67	1	"	1	"	"	ND	1	20	3	3	1	ND	"	ND
69	5	"	1	"	2	4	3	ND	2	3	1	"	"	"
71	3	"	7	"	1	8	501	"	14	ND	8	2	"	"

ND - not detectable

Table # 9i (cont'd) G. C. HYDROCARBON DATA UNITS- PPB

Method: Field Cartridge Sampling Location: Downwind

RUN #	ETHENE	ACETYLENE	PROPANE & PROPENE	CYCLO-PROPANE	ISO-BUTANE	n-BUTANE &n-BUTENE	1,3-BUTA-DIENE	2,2-DI-METHYL-PROPANE	n-PENTANE	3-METHYL-BUTENE	n-HEXANE	BENZENE	n-HEPTANE	TOLUENE
72	2	ND	4	ND	25	25	ND	ND	ND	ND	2	1	ND	ND
73	6	"	15	"	3	8	502	"	22	"	ND	ND	"	"
78	3	"	1	"	6	3	27	"	26	52	32	1	"	"
79	26	"	ND	"	19	45	49	"	8	ND	4	6	"	"
80	10	"	9	"	4	6	31	"	2	"	ND	ND	"	"
81	15	"	13	"	6	18	53	"	73	"	10	1	"	"
89	2	9	3	"	1	2	85	"	1	17	ND	ND	"	"
90	3	ND	1	"	ND	1	15	"	90	172	46	"	"	"
91	4	"	3	"	"	1	57	"	4	2	ND	"	"	"
92	2	"	1	"	2	9	ND	"	62	240	179	8	"	"
96	7	"	8	"	ND	8	49	"	102	ND	16	ND	"	"
98	12	25	11	"	1	13	93	6	6	284	7	"	"	"
99	9	ND	4	"	ND	4	50	ND	2	ND	ND	"	"	"
100	3	"	4	"	"	64	7	35	ND	ND	"	"	"	"
101	5	"	8	"	10	48	65	ND	614	366	"	13	"	"
115	9	"	ND	"	ND	1	6	"	2	ND	"	ND	"	"

ND - not detectable

Table # 9i (cont'd) G. C. HYDROCARBON DATA UNITS- PPB

Method: Field Cartridge Sampling Location: Downwind

RUN #	ETHENE	ACETYLENE	PROPANE & PROPENE	CYCLO-PROPANE	ISO-BUTANE	n-BUTANE &n-BUTENE	1,3-BUTA-DIENE	2,2-DI-METHYL-PROPANE	n-PENTANE	3-METHYL-BUTENE	n-HEXANE	BENZENE	n-HEPTANE	TOLUENE
116	7	ND	ND	ND	ND	2	6	ND	1	ND	ND	ND	ND	ND
117	99	"	ND	"	ND	3	7	"	3	ND	"	"	"	"
118	12	"	1	"	"	ND	35	"	1	1	"	"	"	"
119	8	"	ND	"	"	2	15	"	1	ND	"	"	"	"
120	75	"	"	"	"	1	14	"	1	"	"	"	"	"
121	28	"	9	"	6	27	117	"	62	15	94	108	"	145
122	8	"	6	"	5	7	20	ND	8	ND	ND	ND	"	ND
123	8	"	1	"	ND	1	30	"	ND	"	"	"	"	"
124	47	"	1	"	1	2	19	"	3	"	"	"	"	8
125	6	"	ND	"	ND	ND	6	"	ND	"	"	"	"	ND
126	4	"	ND	"	"	"	16	"	"	"	"	"	"	"
127	4	"	1	"	"	"	40	"	"	2	"	1	"	"
128	6	"	ND	"	"	1	7	"	1	ND	"	ND	"	"
129	22	"	11	"	11	49	24	"	139	67	234	332	453	138
130	12	"	7	"	6	10	32	"	12	5	14	ND	ND	30
131	10	"	ND	"	ND	2	14	"	2	ND	ND	"	"	ND

ND - not detectable

Table # 9i (cont'd) G. C. HYDROCARBON DATA UNITS- PPB

Method: Field Cartridge Sampling Location: Downwind

RUN #	ETHENE	ACETYLENE	PROPANE & PROPENE	CYCLO-PROPANE	ISO-BUTANE	n-BUTANE &n-BUTENE	1,3-BUTA-DIENE	2,2-DI-METHYL-PROPANE	n-PENTANE	3-METHYL-BUTENE	n-HEXANE	BENZENE	n-HEPTANE	TOLUENE
132	8	ND	ND	ND	3	9	35	ND	14	ND	18	ND	ND	ND
135	4	"	3	ND	ND	4	63	"	4	"	1	1	"	"
136	4	"	1	"	2	7	40	"	16	"	20	1	"	"
145	2	"	2	"	2	8	45	"	19	"	ND	ND	"	"
146	3	"	ND	"	ND	1	24	"	6	"	"	"	"	"
147	2	"	ND	"	1	4	22	"	4	"	"	"	"	"
148	3	"	3	"	ND	2	42	"	4	"	"	"	"	"
149	1	"	4	"	6	20	36	"	206	50	28	32	"	"
152	1	ND	5	"	2	4	68	"	6	ND	1	ND	"	ND
153	ND	ND	ND	"	1	3	7	ND	9	ND	ND	ND	"	ND

ND - not detectable

Table # 9j G. C. HYDROCARBON DATA UNITS- PPB

Method: Field Cartridge Sampling Location: Downwind of Gaswells

RUN #	ETHENE	ACETYLENE	PROPANE & PROPENE	CYCLO-PROPANE	ISO-BUTANE	n-BUTANE &n-BUTENE	1,3-BUTA-DIENE	2,2-DI-METHYL-PROPANE	n-PENTANE	3-METHYL-BUTENE	n-HEXANE	BENZENE	n-HEPTANE	TOLUENE
43	2	4	314	ND	869	796	30	ND	323	35	130	136	114	13
44	ND	1	4	"	ND	10	32	ND	5	13	11	7	1	ND
45	4	ND	23	"	36	41	66	ND	16	ND	ND	ND	ND	"
47	156	ND	213	"	179	228	12	ND	56	7	23	ND	ND	"
48	15	ND	60	"	ND	64	192	2	27	47	7	ND	ND	"

ND - not detectable

Table # 9k G. C. HYDROCARBON DATA UNITS- PPB

Method: Field Cartridge Sampling Location: Downwind Pipline

RUN #	ETHENE	ACETYLENE	PROPANE & PROPENE	CYCLO-PROPANE	ISO-BUTANE	n-BUTANE &n-BUTENE	1,3-BUTA-DIENE	2,2-DI-METHYL-PROPANE	n-PENTANE	3-METHYL-BUTENE	n-HEXANE	BENZENE	n-HEPTANE	TOLUENE
108	ND	ND	6	ND	5	17	4	ND	35	11	50	ND	ND	71
109	ND	ND	13	ND	8	26	7	ND	52	29	90	108	ND	228

ND - not detectable

Table # 91 G. C. HYDROCARBON DATA UNITS- PPB

Method: Field Cartridge Sampling Location: Blank Cartridges

RUN #	ETHENE	ACETYLENE	PROPANE & PROPENE	CYCLO-PROPANE	ISO-BUTANE	n-BUTANE &n-BUTENE	1,3-BUTA-DIENE	2,2-DI-METHYL-PROPANE	n-PENTANE	3-METHYL-BUTENE	n-HEXANE	BENZENE	n-HEPTANE	TOLUENE
46	11	ND	2	ND	ND	1	6	ND	ND	ND	ND	ND	ND	ND
70	133	ND	7	ND	ND	2	1	ND	1	2	ND	ND	ND	ND

ND - not detectable

Table # 9m G. C. HYDROCARBON DATA UNITS- PPB

Method: Field Cartridge Sampling Location: Comparison of 50 ml/min and 100 ml/min flow rates

RUN #	FLOW RATE	ETHENE	ACETYLENE	PROPANE & PROPENE	CYCLO-PROPANE	ISOBUTANE	n-BUTANE & n-BUTENE	1,3-BUTA-DIENE	2,2-DI-METHYL-PROPANE	n-PENTANE	3-METHYL-BUTENE	n-HEXANE	BENZENE	n-HEPTANE	TOLUENE
87	50	11	ND	4	ND	ND	2	18	ND	ND	ND	ND	ND	ND	ND
85	100	3	"	2	"	"	1	27	"	"	"	"	"	"	"
115	50	9	"	ND	"	"	1	6	"	2	"	"	"	"	"
123	100	8	"	1	"	"	1	30	"	ND	"	"	"	"	8
116	50	7	"	ND	"	"	2	6	"	1	"	"	"	"	ND
124	100	47	"	1	"	1	2	19	"	3	"	"	"	"	"
117	50	99	"	ND	"	ND	3	7	"	3	"	"	"	"	"
125	100	6	"	ND	"	"	ND	6	"	ND	"	"	"	"	"
118	50	12	"	1	"	"	"	35	"	1	1	"	"	"	"
126	100	4	"	ND	"	"	"	16	"	ND	ND	"	"	"	"
119	50	8	"	ND	"	"	2	15	"	1	"	"	"	"	"
127	100	4	"	1	"	"	ND	40	"	ND	2	"	1	"	"
120	50	75	"	ND	"	"	1	14	"	1	ND	"	ND	"	"
128	100	6	"	ND	"	"	1	7	"	1	"	"	"	"	"
121	50	28	"	9	"	6	27	17	"	62	15	94	108	"	145
129	100	22	"	11	"	11	49	24	"	139	67	234	331	453	138

ND - not detectable

Table # 9m (cont'd) G. C. HYDROCARBON DATA UNITS- PPB

Method: Field Cartridge Sampling Location: Comparison of 50 ml/min and 100 ml/min flow rates

RUN #	FLOW RATE	ETHENE	ACETYLENE	PROPANE & PROPENE	CYCLO-PROPANE	ISOBUTANE	n-BUTANE & n-BUTENE	1,3-BUTA-DIENE	2,2-DI-METHYL-PROPANE	n-PENTANE	3-METHYL-BUTENE	n-HEXANE	BENZENE	n-HEPTANE	TOLUENE
122	50	8	ND	6	ND	5	7	20	ND	8	ND	ND	ND	ND	ND
130	100	12	"	7	"	6	10	32	"	12	5	14	"	"	30
131	50	10	"	ND	"	ND	2	14	"	2	ND	ND	"	"	ND
135	100	4	"	3	"	"	4	63	"	4	"	1	1	"	"
132	50	8	"	ND	"	3	9	35	"	14	"	18	ND	"	"
136	100	4	"	1	"	2	7	40	"	16	"	20	1	"	"
133	50	6	"	ND	"	ND	ND	20	"	ND	"	ND	ND	"	"
137	100	6	"	3	"	1	1	32	"	"	"	"	"	"	"
134	50	19	"	2	"	ND	1	43	"	"	"	"	"	"	"
138	100	3	"	2	"	"	ND	26	"	"	"	"	"	"	"
141	50	ND	"	4	"	6	20	39	"	100	48	"	2	"	"
149	100	1	"	4	"	6	20	36	"	206	50	28	3	"	"
142	50	3	"	3	"	3	6	44	"	37	ND	ND	ND	"	"
150	100	ND	"	ND	"	1	3	7	"	23	"	"	1	"	"
143	50	1	"	11	"	4	23	65	"	37	72	"	4	"	"
151	100	1	"	4	"	3	15	56	"	42	44	"	4	"	"

ND - not detectable

Table # 9m (cont'd) G. C. HYDROCARBON DATA UNITS- PPB

Method: Field Cartridge Sampling Location: Comparison of 50 ml/min and 100 ml/min flow rates

RUN #	FLOW RATE	ETHENE	ACETYLENE	PROPANE & PROPENE	CYCLO-PROPANE	ISOBUTANE	n-BUTANE & n-BUTENE	1,3-BUTA-DIENE	2,2-DI-METHYL-PROPANE	n-PENTANE	3-METHYL-BUTENE	n-HEXANE	BENZENE	n-HEPTANE	TOLUENE
145	50	2	ND	2	ND	2	8	45	ND	19	ND	ND	ND	ND	ND
152	100	1	"	5	"	2	4	68	"	6	"	"	1	"	"
146	50	3	"	ND	"	ND	1	24	"	6	"	"	ND	"	"
153	100	ND	"	"	"	1	3	7	"	9	"	"	"	"	"

ND - not detectable

TABLE 10

GEOMETRIC MEANS OF HYDROCARBONS

Method	Location	# of samples	ethene	propane & propene	1,3-Butadienne	3-Methyl-butene	n-Hexane	Benzene	Toluene	Isobutane	n-Butane& n-Butene	n-Pentane
1) Sampling by MAM unit	Downwind Hydro	7	4	3	3	1	2	2	4	1	2	1
	Downwind Texaco	14	2	3	2	1	3	1	2	3	8	5
	Upwind	2	9	1	10	ND	4	1	1	ND	2	12
2) Airborne Cartridge Sampling	Downwind Hydro	5	7	1	76	5	2	1	ND	ND	3	2
	Downwind Texaco	5	69	2	95	2	1	ND	ND	1	4	1
	Upwind	7	141	2	39	1	1	1	1	1	3	ND
	Exhaust	2	416	28	116	ND	7	2	2	12	17	6
3) Field Cartridge Sampling	Downwind	58	7	2	18	2	2	1	1	2	4	5
	Upwind	24	5	2	13	1	1	1	ND	1	3	2
	Gaswells	5	6	52	43	9	10	3	1	17	86	33
	Pipeline	2	ND	9	5	18	67	7	127	6	21	43
	Blanks	2	38	4	2	1	ND	ND	ND	ND	1	1

units ppb
ND not detectable


9693600009234